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J. GALL INGLIS, F.R.A.S., AND A. P. NORTON

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PREFACE

THE first Edition of this Atlas was published in the year 1910. The work was primarily designed for those amateur telescopists whose instruments are mounted either on alt-azimuth stands or as equatorials without graduated circles. It was also intended to be used as a companion to Webb's invaluable "Celestial Objects for Common Telescopes," and Smyth's admirable "Cycle of Celestial Objects," both now out of print. Practically all the objects contained in the latest editions of these two works, down to and including stars of the seventh magnitude, are shown in the maps, also several fainter objects of particular interest.

Owing to the plan and arrangement of the maps, and also on account of the large overlap, a view of about one-fifth of the entire heavens is shown on one folio, and no constellation is inconveniently broken up. The distortion is slight considering the large area represented. Altogether the charts indicate the positions of over 8,400 stars and 600 nebulæ.

A sketch Map of the Moon, indicating the more important features, and two charts of the Galactic regions, are provided; the latter, having R.A. and Dec. lines as well as galactic co-ordinates, will be helpful in galactic studies. Bright variable and red stars are indicated by a small "V" and "R" respectively, but double stars could not be similarly lettered without sacrificing the clearness of the maps. For particulars of these objects, reference should be made to the lists on the back of the maps and to "Webb" and "Smyth."

For the 8th Edition the letterpress was re-arranged, and this new order has been retained in the present Edition. First come the various reference lists and tables on pages vi to xvi. These are followed by the sections of the Reference Handbook:—

I. Notes on Star Nomenclature.
II. Notes on Astronomical Terms.
III. The Galaxy and the Stars.
IV. Spectroscopy.
V. The Sun, Moon, and Planets; Celestial Phenomena.
VI. Hints on Observing.
VII. The Care and Use of the Telescope.

The underlying idea has been to furnish both the amateur observer and the general reader with a reference book to which he can turn for an explanation of unfamiliar terms—observational terminology especially being very inadequately dealt with in text-books. These explanations are necessarily much compressed, but it is hoped they are sufficiently complete for the required purpose. Sources of fuller information are often given.

The Constellation boundaries used are those prepared by Mons. E. Delporte, and adopted by the International Astronomical Union in 1930. The epoch of Mons. Delporte's boundaries is 1875, and by 1950 the change of their positions in R.A. and Dec., due to 75 years of precession, is appreciable. With respect to the stars themselves the positions of the boundaries always remain unaltered.

The kind and encouraging testimony as to the usefulness of my Star Maps given by professional and amateur astronomers, both at home and abroad, especially in the United States of America, induced me a few years ago to re-draw all the main charts for the new standard epoch 1950. In this Edition, the former Index Maps and Galactic Charts have been replaced by new and more complete ones.

All the main features of the previous maps have been retained, but with certain alterations:—

(*a*) Stars from the Revised Harvard Photometry down to magnitude 6·35 have been charted. In the original edition of this work, the star places were taken mainly from Houzeau's "Uranométrie Générale." A careful comparison of the magnitudes of Houzeau's fainter naked-eye stars with the same stars included in the H.R. and its Supplement, showed that many of his stars are placed at a lower, sometimes a much lower magnitude than 6·35 on the Harvard scale. Such stars have now generally been omitted. On the other hand, many Harvard stars, not in Houzeau, have been inserted, as well as several additional double stars from various sources.

(*b*) All nebulæ, except those of Messier and those classed by Herschel (see p. 55), have now received the N.G.C. numbers.

(*c*) Variable stars which reach at their maximum brightness the 6th or 7th magnitude, have been indicated in the maps by small circles.

(*d*) The Galactic Equator and Poles now adopted are those recommended by the International Astronomical Union, and differ slightly in position from those which have appeared in the earlier maps.

The Milky Way is in many places extremely complex, varying much in brightness, with cloudy wisps of light, dark spaces and dark winding lanes. No single-tint representation, such as is used in this atlas, can satisfactorily represent it; but the outline of Proctor has been followed, for it does at least indicate the general position of the Milky Way and also suggests its complexity.

(*e*) The Abbreviation List printed in the margins of the 1920 maps was necessarily limited. It has been superseded by the complete List of Abbreviations given on page 55, preceding the charts.

Since the regretted death, early in 1939, of Mr J. Gall Inglis, who was responsible for most of the introductory matter up to page 44, I have been much indebted to his son, Mr R. M. Gall Inglis, for some helpful suggestions, especially with regard to the re-arrangement of the text. A few corrections and additions have been made in this Edition.

ARTHUR P. NORTON

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Star Catalogues are mostly found only in the annals of observatories or astronomical societies. They are of two types: (*a*) *Catalogues of precision*, giving the positions with all possible accuracy; (*b*) *Durchmusterungen*, designed to give star positions to mag. 9 with moderate accuracy only. 1950 is the standard epoch for the present.

A survey of star catalogues from the time of the earliest Greek astronomers till well on in the 19th century, will be found in the *Memoirs R.A.S.*, Vol. 43: the triennial *Transactions* of the I.A.U. reviews the latest issues. See also Valentiner's *Handwörterbuch der Astronomie*. Some notes on catalogues are given below; various contractions, on p. vii.

In star catalogues, the + and − signs for precession and proper motion are added algebraically, so that in correcting the star's place, *like signs are added, unlike signs subtracted.*

General Catalogues.—The most complete catalogue of precision is that of the Astronomische Gesellschaft (A.G.C. or A.G), which gives positions for all stars to mag. 9, N. of 20° S. Dec.

Boss's Preliminary General Catalogue (P.G.C., 2nd Edition, 1915), gives accurate positions and proper motions of all naked-eye stars: magnitudes are on an old light ratio, see p. 16. A more extended one is in preparation.

The Henry Draper Catalogue (H.D.), gives the positions, magnitudes, and spectral type of 225,000 stars to about magnitude 10 (*H.A.*, vols. 90-99; precession and proper motion data are not given). Earlier works are the *Revised Harvard Photometry* (H.R.) 1908, in *H.A.* vol. 50; the *H.P.*, 1898; Gould's *C.G.A.*, 1886, and *U.A.*, 1879.

Dritter Fundamental Katalog. (F.K.3) of the Berliner Astron. Jarbuch. To be used as basis of international ephemerides.

Schlesinger's Catalogue of Bright Stars (B.S.) to mag. 6·5, *Pub. Yale University Obs.*, 1930. [by side.

Backhouse's Cat.., 1911, of all naked-eye stars, is good and inexpensive; the magnitudes of various authorities are given side

The N.A. gives some 500 bright-star positions annually. The *Geschichte des Fixsternhimmels* (G.F.H.), when completed, will contain all meridian observations made before 1900.

Parallaxes. *Schlesinger's Catalogue* is a compilation of all published parallaxes, revised to 1935 (*Pub. Yale University Obs.*). *Boss's P.G.C.*, see above. *Spectroscopic Absolute Magnitudes and Parallaxes, Mt. W. Contr.*, No. 511.

Proper Motions.—*Boss's P.G.C.*, see above. *Pub. Cincinnati Observ.*, vol. 18, gives all proper motions known to exceed 10″ per century. The *Eigenbewegungs Lexikon* (E.B.L., *Hamburg Obs.*), gives references to all published proper motions to 1935.

Radial Velocities.—List of over 1000, *Ap. J.*, vol. 57. *Moore's Radial Velocity Catalogue* of Stars, Nebulæ and Clusters, *Pub. Lick Obs.*, Vol. 18, 1932.

Nebulæ and Clusters.—The standard work is the 'N.G.C.' or *New General Catalogue* (in vol. 49, *Memoirs R.A.S.*), extended by the *Index Catalogue* (I.C.), 1904, 1908; see also Melotte's list, *Mem. R.A.S.*, vol. 60, part v., p. 125. For lists of the Globular Clusters, see *H.A.* vol. 76, and *H.C.O. Bulletin*, 776.

Dark Nebulæ.—Barnard's Photographic Atlas and Catalogue of Dark Nebulæ. (*Ap. J.*, vol. 49, 1919.)

Variable Stars.—See Hagen's *Atlas Stellarum Variabilium* with catalogue (1899-1908); various publications of Harvard College Observatory, and the Reports and Annual Handbook of the B.A.A.

Double Stars.—*Burnham's General Catalogue of Double Stars* (B.G.C.), and additional vols. *Aitken's Double Stars* (A.D.S.), within 120° of N. Pole, epochs 1900, 1950; all measts. to 1926; practically *B.G.C.* extension; *Pub. Carnegie Instit., No. 417*, 2 vols. *Innes's Southern Double Star Catalogue* (S.D.S.), south of −19°, about 1927. *Moore's Fourth Catalogue of Spectroscopic binaries*, (*L.O.B.* 483).

Minor Planets.—History and summary of all work done up to (1091) (1928), *Pub. Lick Obs.*, vol. xix, II.

Map of Mercury by M. E. M. Antoniadi, in *L'Astronomie*, Oct. 1935.

Map of Mars, by M. E. M. Antoniadi, in four plates, 8vo., in *L'Astronomie, 1930*, p. 411. A beautiful map, from the same author's *La Planète Mars, 1659-1929*; 240 pp., 4to., Paris; a valuable summary. See also Webb's *Celestial Objects.*

Maps of the Moon. See p. 31; also "Who's Who in the Moon," notes on all lunar formations adopted by I.A.U. (*Mem. B.A.A., 1938*).

Wave-lengths.—*Rowland's (Revised): Pub. Carnegie Institute*, No. 396.

Galactic Co-ordinates. Table in *Schlesinger's Catalogue* (B.S., above), and *Lund Annals*, vol. 3, 1932, for 12h. 40m. +28°, 1900; also in *M.N.*, vol. 53, p. 74 (Marth, see p. 10). See also Charts 17-18.

Telegraphic Code (I.A.U., Revised 1935). See B.A.A. annual *Handbook*, 1936, for the more important items.

The Year's Progress.—See the Annual Report of the Royal Astronomical Society (Feb.), a valuable summary; it gives the names and numbers of the recognised minor planet discoveries. The Yearbook of the Carnegie Institute gives some useful summaries. *Science Abstracts* (Physical Section) indexes papers in the principal astronomical publications of the world. See also the *Bulletin Astronomique*, and the *Astronomische Jahrbuch.*

For earlier astronomical literature, the *International Catalogue* (discontinued 1917) indexed annually, under the various subjects, the papers in the principal astronomical publications of the world. Houzeau's *Vade Mecum de l'Astronome* (1882) is also a good guide.

Star Counts or Gauges, originated by Sir W. Herschel, are used for ascertaining the distribution of the stars on the star sphere. A number of representative areas are selected; the stars in each are carefully counted, and their positions, magnitudes, proper and radial motions, spectra, and parallaxes, ascertained, so far as is possible. A Table of the number of stars of each magnitude, per square degree, is given in the B.A.A. Handbook for 1926.

Selected Areas (*Kapteyn's*; S.A.), a great photographic Star Count of some 250,000 stars (limiting mag. 16, International), had, as planned, 206 representative areas, each 75′ square, or circles 42′ in radius, on or near the circles of N. and S. Dec. 0°, 15°, 30°, 45°, 60°, 75°, 90°; also 46 Milky Way areas: this, however, proved too onerous for rich regions, and some areas were restricted thus—Galactic longitude N. and S., 0°-20°, 40′ × 40′; 20°-40°, 60′ × 60′; 40°-90°, 80′ × 80′. The results are being published by the various co-operating observatories over the world; refer to *Trans. I.A.U.* reports.

Harvard Standard Regions.—Similar to the *N. Polar Sequence* (p. 12; *H.A.*, vol. 76, No. 3). A catalogue of 2500 stars, giving magnitudes, spectra, colour indices, &c., for the whole sky; 48 centres of 30° each; *H.A.*, vol. 76, No. 4.

Astronomical Societies, Publications, &c.—Contractions commonly used. Standard contractions are now being prepared. first list of General Contractions, and those for Places., see Trans. I.A.U. 1928.

Publication, or Society.

A.A.S. American Astronomical Society.
A.A.V.S.O. American Association of Variable Star
A.E. American Ephemeris. [Observers.
A.G. Astronomische Gesellschaft
A.J. Astronomical Journal.
A.N. Astronomische Nachrichten.
Ap.J. Astrophysical Journal.
A.S.P. Astronomical Society of the Pacific.
B. Bulletin (Prefixed).
B.A. British Association.
„ Bulletin Astronomique.
B.A.A. British Astronomical Association.
B.A.N. Bulletin of the Ast. Inst. of the Netherl ands
B.J. Berliner Jahrbuch.
B.S.A.F. Bulletin de la Société Astronomique de
C.O. Cincinnati Observatory. [France.
C.R. Comptes Rendus (Paris Acad. Sciences).
C.T. Connaissance des Temps.
D.A.O. Dominion Astrophysical Observ., Victoria,
D.O. Dominion Observatory (Ottawa). [B.C.
E.B. Encyclopedia Brittannica.
E.M. English Mechanic.

Publication, or Society.

H.A. Harvard Observatory Annals.
H.B. Harvard Bulletin.
H.C. Harvard Circular (Harv. C.).
H.C.O. Harvard College Observatory.
I.A.U., I.U.A., U.I.A. Internat. Astron. Union.
J. Journal. (prefixed to Society name, as *J.B.A.A.*).
J.O. Journal des Observateurs.
L.O.B. Lick Observatory Bulletin (Lick B.)
M.N. Monthly Notices Royal Astron. Society.
Mt.W., M.W. Mt. Wilson Observatory.
Nat. Nature.
N.A. Nautical Almanac.
Obs. The Observatory.
P. Publications, Proceedings. (prefixed to Society
P.A. Popular Astronomy. [name, as, *P.A.S.P.*).
P.A.S.P. Pub'ns of Astronomical Socy. of the Pacific.
Phil. Trans. Philosophical Transactions of the Royal
R.A.S. Royal Astronomical Society. [Socy.
R.A.S.C. Royal Astronomical Society of Canada.
S.A. Scientific American.
„ Selected Areas *(Kapteyn's)*, p. vi.
U.O.C. Union Observatory Circulars.
V.J.S. Verteljahrsschrift der Astron. Gesellschaft.

General.

An. Annals.
App. Appendix.
Ass. Association.
B., Bull. Bulletin.
Cat. Catalogue.
Cir. Circular.
Cont. Contributions.
Edn. Edition.
I. International.
Ist., Inst. Institute.
M., Mem. Memoirs.
Mag. Magazine.
O., Obs. Observatory.
Pr. Proceedings.
P., Pub. Publications, or Published.
R. Review.
Rp. Report.
S., Socy. Society.
S. Smithsonian.
Tr. Transactions.
Vol. Volume.
Yb. Yearbook.
Zs Zeitschrift

Astronomical Catalogues.—Contractions in ordinary use. The letters are often used without points.

Contraction.	*With number added, =Number in: —*
A.C.	Astrographic Catalogue,* to mag. 11 (in progress).
A.D.S.	Aitken's Double Star Catalogue, 1932 (see p. vi).
A.G., A.G.C.	Astronomische Gesellschaft, Catalogues (see p. vi).
Arg.	Argelander. (See B.D. below). [Also = C.G.A.
B.	Birmingham's Catalogue of Red Stars, 1877. (See E-B.).
B.	(In *Nautical Almanac*) Bode's Catalogue, 1801.
B.A.C.	British Association Catalogue, epoch 1850 (*Baily*, 1845).
B.D.	Bonn Durchmusterung (*Argelander*) to mag. 9, 1859-62,* 2° to 23° South Dec., extended by Schönfield (1886).
β	Burnham's Double Star Catalogues (not his General Cat.,
B.G.C.	Burnham's General Cat. of Double Stars. [B.G.C.)]
Br.	Auwer's reduction of Bradley's Observations.
Bris. or Br.	Sir T. Brisbane's Catalogue of Southern Stars, 1835.
C.D.	Cordoba Durchmusterung, 22° to 62° S. [(*Gould*) 1886,
C.G.A.	Catalogo General Argentino, 32,448 Southern Stars.
C.P.D.	Cape Photographic Durchmusterung, to mag. 9, 19° to 90° South Dec. (*Gill and Kapteyn*), 1896-1903.
C.Z.	Cordoba Zone Cat. of South Stars, Nos. in zones of Dec.*
Δ	Dunlop's Catalogues of Double stars and Nebulæ, 1828.
E-B.	Espin's edition of Birmingham's Cat. of Red Stars, 1888.
E.B.L.	Eigenbewegungs Lexikon (*Hamburg Obs.*) of all known
FK 3	Dritter Fundamental Katalog (p. vi.). [proper motions.
G.	(In Brit. Naut. Almanac) = U.A.
G.F.H.	Geschichte des Fixsternhimmels, see p. vi.
Gr.	Groombridge's Cat. of Circumpolar Stars for 1810, 1838.
H.	Sir W. Herschel's Catalogues of Double Stars, 1782-1822.
„	(In *Nautical Almanac*) Hevelius's Catalogue, 1660.
H'.	(„ „) Heis' Catalogus Stellarum, 1872.
Houz.	Houzeau's Uranométrie Générale, 1878.
h.	Sir J. Herschel's Catalogues of (1) Nebulæ, 1833, 1847; and (2) of Double Stars.

Contraction.	*With number added, =Number in:—*
H.D.	Henry Draper Cat. 1918-24 (vols. 91-99, Harvard Annals),
H.P.	Harvard Photometry (*Pickering*), 1884. (*H.A.* vol. 14).,
H.R. (also R.H.P.).	Revised Harvard Photometry, 1908 (vol. 50.
I.C.	Index Catalogue, extension of N.G.C. 1904, 1908. [*H.A.*).
Jac.	Jacob's Catalogue of Double Stars.
Lac.	Lacaille's Catalogue of Southern Stars, Epoch 1750, published by the British Association, 1847.
Ll. or Lal.	Lalande's Cat., Epoch 1800, pub. by the *B.A.*, 1837.
M.	Messier's Catalogue of 103 Nebulæ & Clusters, pub. 1784. Reprinted, *Obs.*, Aug. 1918; and *P.A.S.P.* Aug, 1917,
N.G.C.	New General Catalogue (of Sir J. Herschel's Nebulæ and Clusters, *Dreyer*), 1888. Vol. 49, Memoirs, R.A.S.
O.A.	Oeltzen's reduction of Argelander's Zone Observations,
P.D.	Potsdam General Cat. (Supplementary vols., P.P.D., &c.)
P.G.C.	Preliminary General Catalogue of 6188 stars (*Boss*), 1910.
ph.	Great International Photographic Star Map.
Pi.	Piazzi's Star Cat., epoch 1800, 1803-14.†
Rus.	Russell's Double Star Measures (Sydney), 1891.
S.	South's Measures of Double Stars, 1826.
Sa.	Santiago Observations, 1876.
S.D.S.	Southern Double Star Catalogue *(Innes)* 1927.
S.M.P.	Southern Meridian Photometry (Harvard), 1895.
St.	Stone's Cape Catalogue for 1880, or Radcliffe Cat., 1890.
W.B.	Weisse's reduction of Bessel's Zones, equinox 1825; Nos. in
W.Z.C.	Washington Zodiacal Cat., 1900, 1920. [hrs. of R.A.
U.A.	Uranometria Argentina (*Gould*), 1879.
U.O.	Uranometria Nova Oxoniensis (*Pritchard*), 1885.
Σ	Wilhelm Struve's Dorpat Cat. of Double Stars, 1837.
ΣI	do. do. Appendix I.
OΣ	Otto Struve's Revised Pulkova Catalogue, 1850.
OΣΣ	Pulkova Catalogue, Part II.

* In this case the zone is stated as well as the number: thus B.D. +13° 2302 means star No. 2302 in the 13° zone, north Dec., in the B.D.
† The numbering commences anew in each hour of R.A.: thus V^h 123 denotes star No. 123 in the zone of 5 h. R.A.

Bode's Law.—Taking Mercury as 4, adding 4 to each term of the geometrical series 3, 6, 12, 24, &c., gives the approximate distances of the planets up to Uranus, but not Neptune's: Pluto is near the position Neptune should occupy. No reason is known for this curious relation. Bode remarked that a planet was missing at the distance where the asteroids were discovered later.

Planet ..	Mercury	Venus	Earth	Mars	Asteroids	Jupiter	Saturn	Uranus	Neptune	Pluto	..	..	..
Geometrical Series ...	3	6	12	24	48	96	192	384	768	...	...	...	
Add ...	4	4	4	4	4	4	4	4	4	...	...	...	
Dist. fr. Sun, Bode	4	7	10	16	28	52	100	196	388	772	...	...	...
,, Actual ...	3·9	7·2	10	15·2	27·4	52	95·4	192	301	395	...	...	...

Albedo of the Planets. Russell's figures are for *Bond's Albedo* (somewhat different from Lambert's original definition on p. 7: see *Ap. J.*, vol. 43, 1916).

Albedo:—	Mercury	Venus	Earth	Moon	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto		
(Zöllner, 1865) ...	·13	·50	...	·17	·27	·62	·52	·64	·46	...	...	Clouds ·65-·72
(Müller, 1897) ...	·14	·76	·20	·13	·12	·62	·72	·60	·52	...	...	Snow ·70-·78
(Russell, 1916) ...	·07	·59	·45	·07	·15	·56	·63	·63	·73	...	...	

Saturn's Rings.—Approximate date of Earth passing the ring-plane; and Saturn's heliocentric longitude. Dates not "0°" are minima: the Earth did not quite pass the plane of the ring in 1936, though extremely near doing so.

Date	*lat.*	*long.*	*Date*	*lat.*	*long.*	*Date*	*lat.*	*long.*	*Date*	*lat.*	*long.*	*Date*
1889 Dec. 13.	−7°·9	153½°	1907 Apr. 13.	0°	349°	1920 Nov. 7.	0°	167°	1936 Jun. 28.	(+0°)	346°	1950 Sept. 14
1891 Sept. 22.	0°	170½°	,, Oct. 4.	0°	354°	1921 Feb. 22.	0°	183°	1937 Feb. 21.	0°	354°	... ...
1892 May 31.	+0°·4	179⅓°	1908 Jan. 7.	0°	358°	,, Aug. 2.	0°	189°	,, Nov. 28.	−2½°	4°	... ...

Parallaxes:—Sun. Adopted at Paris Conference, 1911. 8″·80.*

Moon. Equatorial horizontal parallax, at mean distance, 57′ 2″·7.

Asteroids (approximate maximum). *Eros*, 52″. *Amor*, 73″. *1932 H.A.*, 4′. *Adonis*, 8½′.

Stars. The parallaxes of several of these are given in the Tables of the Brightest and Nearest Stars on page 53.

Planetary Colour Indices, &c.—"Sun's Radiation" gives the amount received per unit of area.

	Mercury	Venus	Earth	Moon	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto		
Colour Index (Sun 0·72)	+...	+0·91	...	+1·2	+1·45	+0·96	+1·22	+0·94	+...	0·67	...	...
Sun's Radiation ...	6·6	1·9	1·0	1·0	0·43	0·04	0·01	0·003	0·001	0·0006	...	...
Velocity of escape, km/secs.	3·6	10·2	11·2	2·4	5·0	60	36	21	23	3?	...	...

Stellar Colour Indices.—

Type of Star.	O	B0	A0	F0	G0	K0	M	M3	Nc	R	S
Colour Index, ... Giants ...	−0·32	0·0	+0·38	+0·86	+1·48	+1·88	...	+5·5	...	...	
do ... ... Dwarfs ...	−0·32	0·0	+0·38	+0·72	+0·99	+1·76	...	...	...	...	
Heat Index (average), in Magnitudes ...	−0·1	0·0	+0·3	+0·7	+1·2	+2·3	...	...	...	...	
Surface Brightness, ,, Giants ...	−3·2	−2·3	−1·0	+0·3	+2·3	+4·5	...	...	...	...	
do ,, Dwarfs ...	−3·2	−2·3	−1·0	0·0	+1·2	+3·8	...	...	...	...	

Novæ.—Many so-called New Stars have been recorded in years previous to those given in the list below. Thus the appearance of a new star about the year 150 B.C. is said to have led Hipparchus to make his catalogue of stars. But generally, the old records are vague and indefinite, and, in some cases, undoubtedly refer not to Novæ but to comets.

Modern Novæ.—Only the brighter Novæ are included in this List.

Year A.D.	Nova:—	Greatest Mag.	Approx. Long.	Galac. Lat.	Position 1950. R.A.	Dec.
1572.	Cassiopeiæ (B)	>1	88°	+ 2°	0h. 22 m.	+63° 53′
1600.	Cygni No. 1 (P)	3·5	43	+ 0	20 16	+37 52
1604.	Ophiuchi No. 1	>1	332	+ 5	17 28	−21 27
1670.	Vulpeculæ (11)...	3	31	− 0	19 46	+27 11
1848.	Ophiuchi No. 2	5·5	335	+16	16 57	−12 48
1860.	Scorpii (T) ...	7	321	+18	16 14	−22 31
1866.	Coronæ (T) ...	2	10	+47	15 57	+26 4
1876.	Cygni No. 2 (Q)	3	58	− 8	21 40	+42 34
1885.	Andromedæ (S)	7	89	−21	0 40	+40 59
1887.	Persei No. 1 (V)	9·2	100	− 4	1 58	+56 29
1891.	Aurigæ (T) ...	4·5	145	− 0	5 29	+30 25
1893.	Normæ (R) ...	7	295	+ 4	15 26	−50 25
1895.	Carinæ (RS) ...	8	259	− 1	11 6	−61 40
1895.	Centauri (Z) ...	7	283	+29	13 37	−31 23
1898.	Sagittarii No. 1	4·7	350	−10	18 59	−13 14
1899.	Sagittarii No. 3	8·5	335	− 6	18 17	−25 13
1899.	Aquilæ No. 1 ...	7	4	− 8	19 18	− 0 14
1901.	Persei No. 2 ...	0·0	119	− 9	3 26	+43 24
1903.	Geminorum No. 1	5·1	153	+13	6 41	+30 0
1905.	Aquilæ No. 2 ...	9	358	− 6	19 0	− 4 31
1910.	Sagittarii No. 2	7·5	331	− 3	17 57	−27 33
1910.	Lacertæ No. 1	5·0	71	− 5	22 33	+52 22
1910.	Aræ	6·0	302°	− 5°	16h 37m	−52° 20′
1912.	Geminorum No. 2	3·3	152	+16	6 52	+32 12
1913.	Sagittæ ...	7·2	25	− 9	20 5	+17 32
1917.	Ophiuchi No. 5	6·5	321	+ 8	16 50	−29 33
1918.	Aquilæ No. 3	−0·7	1	− 1	18 46	+ 0 32
1919.	Ophiuchi ...	7·5	7	+12	18 11	+11 35
1919.	Lyræ ...	6·5	27	+11	18 51	+29 9
1920.	Cygni No. 3 ...	1·8	55	+12	19 57	+53 29
1925.	Pictoris (RR) ...	1·1	240	−25	6 35	−62 36
1934.	Herculis ...	1·3	40	+25	18 7	+45 51
1936.	Lacertæ ...	2·0	70	− 1	22 14	+55 23
1936.	Aquilæ ...	7·0	5	− 6	19 15	+ 1 38
1936.	Sagittarii ...	4·5	325	− 8	18 5	−34 21
1936.	Aquilæ ...	5·0	11	− 6	19 24	+ 7 30
1942.	Puppis ...	0·4	221	+ 0	8 10	−35 13
1946.	Coronæ (T) ...	3·1	...	(See	yr. 1866	above)
1950.	Lacertæ ...	6·0	73	− 5	22 48	+53 2

* From observations of Eros around the opposition of 1931, the value is 8″·790 ± 0″·001 (see B.A.A. Handbook for 1942).

Nomenclature of Minor Planets, Variable Stars, Novæ, &c.—Systems that answered well in the early stages of discovery inevitably tend to become inadequate or unwieldy as discoveries increase, and from time to time they have to be revised. The following modifications have been made in the original systems.

Minor Planets. Each new discovery, before the number and name is given (p. 35), is temporarily assigned distinctive Roman letters, as not infrequently, a supposed new asteroid proves to be identical with one already known. Originally a single letter sufficed, and the year ; but in 1893, the double form AA to AZ, BA to BZ, &c., was introduced (I being omitted), this new series being continued right on until ZZ was reached, instead of beginning the alphabet afresh each year. A second alphabet was begun in 1907, with the year (1907 AA, &c.), and a third in 1916—terminated with UA., Dec. 31, 1924, when a new system was started to enable belated discoveries to be inserted in approximately their proper place.

Under the present system of temporary nomenclature, the double alphabet begins afresh each year; the discoveries of Jan. 1-15 are AA, AB, AC, &c.; of Jan. 16-31, BA, BB, BC, &c.; of Feb. 1-15, CA, CB, &c., the year being added in each case ; if more discoveries than 25 in half a month, AA_1, AB_1, &c. Minor planets are in the care of the Rechen-Institut of Berlin, which attends to the numbering, &c. When unnumbered, the orbit is not sufficiently certain, as 1932 HA, but a name may be given, as it is more convenient for reference. (Annual summary in *M.N.*, February).

Jan. A,B ; Feb. C,D ; Mar. E,F; Apr. G,H ; May J,K ; June L,M ; July N,O ; Aug. P,Q ; Sept. R,S ; Oct. T,U ; Nov. V,W ; Dec. X, Y.

Variable Stars. Argelander designated those not otherwise lettered or numbered, in any constellation, by the Roman capital letters, R, S, T, U, V, W, X, Y, Z. After Z, the double form RR to RZ, SS to SZ, TT to TZ, and so on to ZZ, was used, which provided for 54 variable stars in any constellation. As that number proved insufficient, AA to AZ, BB to BZ, and so on, was employed, J being omitted. The simplest system, which denotes the variables of each constellation by the letter V, followed by a number—thus V1 = R ; V2 = S ; V54 = ZZ, &c., is to be used from V^{335}, when QZ is reached. Letters are assigned when the variability is confirmed ; provisionally, Novæ and ordinary variables are now designated by a number, year, and constellation, Nova Aquilæ 1918 being 7.1918 Aquilæ, in the 'variable' discoveries of 1918.

Novae. The older Novæ are designated by the constellation and year in which they appeared, thus, *Nova* Scorpii, 134 B.C. : some having also a 'popular' name, as *Kepler's Star*, *Tycho's Star*, &c. Modern Novæ were similarly designated till 1925 : if more than one appeared in a constellation, they were numbered successively *Nova* I., *Nova* II., and so on, of that constellation, in order of discovery, disregarding the Novæ before 1572. As many Novæ were only discovered years after their appearance, when comparing star photographs of the same region taken at different times, this sometimes resulted in the numbers being out of order as regards date of *appearance*: the nomenclature was therefore altered to constellation and year, with the date in tenths of a year, if more than one in a year.

Primary and Secondary Stars.—The brightest star is A, the companion or companions B, C, &c., as *Sirius A* and *B*.

Comets.—Entirely new comets are usually named after the discoverer, adding the year, as Donati's comet, 1858.

Comet a, *Comet b*, &c., denotes the first, second, ... comet *discovered* that year, whether new or already known.
Comet I, *Comet II*, &c., „ „ „ „ *arriving at perihelion* that year, ditto

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Some Terms occurring in Astronomical Papers. (Fuller details in Young's Revised Astronomy, *by Russell, &c.*).

Errors of Observation.—These are of two kinds : *Systematic Errors* and *Accidental Errors* (see page 7, *Equation*). The former are detected by observations repeated with different instruments, &c., or by comparison with results obtained by other methods ; the latter errors are erratic, but can be allowed for by analysis of the small discrepancies between the individual observations of a series, or between observed and calculated values—which discrepancies or differences are known as *Residuals*.

The Probable Error (P.E.), of a series of observations is a value derived mathematically from these residuals ; it affords an index to the reliability of the figures given, and is prefixed by the sign ±, which means that it is an even chance whether, by the amount of the probable error, the value given is greater, or less. The smaller the probable error, the greater the reliability.

Method of Least Squares.—A method used to ascertain the most probable mean value derivable from a number of different observations. It is based on the principle that the 'weights' (degree of accuracy) of observations, with different probable errors, are inversely proportional to the squares of their probable errors.

Interpolation; Extrapolation.—*Interpolation* is the process of finding values for dates, hours, quantities, &c., intermediate to those given in a Table. For ordinary purposes, the proportional amount of the difference between the figures for the two nearest dates, quantities, &c., usually suffices, it being assumed, for simplicity, that the change in the interval is uniform ; a more accurate result, useful when maximum or minimum occurs between the dates, is obtained by plotting on squared paper several successive dates, or figures, on each side of the one not given, and drawing a curve through these points.

Extrapolation, a similar process, extends a series of figures beyond the limit of the last figure actually known ; there being only one limiting figure, however, it is less simple than interpolation.

Contracted Notation employs the factor '10,' with small index figures, to express large numbers in a small space. The index figures may be taken as indicating the number of ciphers to be added after the 1. A *minus* before the index figures indicates a fractional number, viz., 1 divided by that number; thus $10^{-6} = 1/1{,}000{,}000$th or ·000001, from which it appears that *minus* index figures show the position, *after* the decimal point, of the first significant figure of the decimal fraction, the number of ciphers before the 1 being *one less* than the index number. The following are examples with decimal factors :—

$1{\cdot}23 \times 10^6 = 1{\cdot}23 \times 1{,}000{,}000$ or $123 \times 10^4 = 1{,}230{,}000$. $1{\cdot}23 \times 10^{-6} = 1{\cdot}23 \times {\cdot}000001$ or $123 \times 10^{-8} = 123 \times {\cdot}00000001 = {\cdot}00000123$.

Note to make the index of the 10 such that the figure before the decimal in the other factor is *1 to 9 only* ; thus $1{\cdot}23 \times 10^6$ is correct, not the 123×10^4 illustrating the working : the index of 10 (both + and −) is then the 'characteristic' of the logarithm of the No.

$10^1 = 10$	= 1 with 1 cipher after it	$10^{-1} = 0{\cdot}1$	= 1 in the 1st place after decimal point.
$10^3 = 1000$	1 „ 3 ciphers „	$10^{-2} = 0{\cdot}01$ (1/100th)	„ „ 2nd „ „ „
$10^6 = 1$ million	1 „ 6 „ „	$10^{-6} = 0{\cdot}000001$ (1/millionth)	„ 6th „ „ „
$10^7 = 10$ millions	1 „ 7 „ „	$10^{-7} = 0{\cdot}0000001$ (1/10-millionth)	„ 7th „ „ „
$10^9 = 1$ billion (U.S.A., &c.)	1 „ 9 „ „	$10^{-9} = 1$/billionth (U.S.A.)	„ 9th „ „ „
$10^{12} = 1$ billion (British) ...	1 „ 12 „ „	$10^{-12} =$ „ (British)	„ 12th „ „ „

Magnitudes and Relative Brightness of the Sun, Planets, and Principal Stars, (1st magnitude star taken as 1·00).

Name of Star, &c.	H.R. Mag.	Brightness
Sun ...	−26·6	{ 109,650 millions
Moon (Full)	−12·2	190,550
Venus (max.)	−4·28	129·4
Jupiter* ...	−2·25	19·95
Mars* ...	−2·25	19·95
Mercury (max)	−1·8	13·18
Sirius ...	−1·58	10·77
Saturn* ...	{ −0·18 / +0·89	8·00 / 1·11
Canopus ...	−0·86	5·55
Magnitude	0·00	2·51
Vega ...	0·14	2·21
Capella ...	0·21	2·07
Arcturus ...	0·24	2·01
α^1 Centauri	0·33	1·85
Rigel ...	0·34	1·84
Procyon ...	0·48	1·61

Name of Star	H.R. Mag.	Relative Brightness
Achernar ...	0·60	1·45
β Centauri ...	0·86	1·14
Altair	0·89	1·11
Betelgeuse ...	0·92	1·08
Magnitude	1·00	1·00
Aldebaran ...	1·06	0·95
Spica	1·21	0·82
Pollux	1·21	0·82
Antares ...	1·22	0·82
Fomalhaut ...	1·29	0·77
Arided ...	1·33	0·74
Regulus ...	1·34	0·73
β Crucis ...	1·50	0·63
α^1 Crucis ...	1·58	0·59
Castor	1·58	0·59
γ Crucis ...	1·58	0·60

Name of Star	H.R. Mag.	Relative Brightness
ϵ Canis Major.	1·63	0·56
ϵ Ursæ Major.	1·68	0·53
γ Orionis ...	1·70	0·52
α^2Centauri ...	1·70	0·52
λ Scorpii ...	1·71	0·52
ϵ Carinæ ...	1·74	0·51
ϵ Orionis ...	1·75	0·50
β Tauri ...	1·78	0·49
β Carinæ ...	1·80	0·48
α Triang. Aust.	1·88	0·44
α Persei ...	1·90	0·44
η Ursæ Major.	1·91	0·43
ζ Orionis ...	1·91	0·43
γ Geminorum	1·93	0·42
ϵ Sagittarii ...	1·95	0·42
α Ursæ Major.	1·95	0·42

Name of Star	H.R. Mag.	Relative Brightness
δ Canis Major.	1·98	0·41
β Canis Major.	1·99	0·40
Magnitude	2·00	0·40
Polaris ...	2·12	0·36
Magnitude	2·50	0·25
,, ...	3·00	0·16
,, ...	3·50	0·10
,, ...	4·00	0.06
,, ...	4·50	0·04
,, ...	5·00	0·03
,, ...	5·50	0·02
,, ...	6·00	0·01
Uranus* ...	5·8	0·01
Magnitude	6·50	0·006
Neptune* ...	7·7	0·003
Pluto*	(14·5)	·000002

Ratio of Brightness, fainter or brighter, for a difference in magnitude ("Diff.") of :—

Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio	Diff.	Ratio
0·1	1·10	0·5	1·58	0·9	2·29	1·3	3·31	1·75	5·01	3·0	15·85	5·5	158·49	8·0	1584·9	10·5	15,849	13·0	158,490
0·2	1·20	0·6	1·74	1·0	2·51	1·4	3·63	1·8	5·25	3·5	25·12	6·0	251·19	8·5	2511·9	11·0	25,119	13·5	251,190
0·25	1·26	0·7	1·91	1·1	2·75	1·5	3·98	1·9	5·75	4·0	39·81	6·5	398·11	9·0	3981·1	11·5	39,811	14·0	398,110
0·3	1·32	0·75	2·00	1·2	3·02	1·6	4·37	2·0	6·31	4·5	63·10	7·0	630·96	9·5	6309·6	12·0	63,096	14·5	630,960
0·4	1·45	0·8	2·09	1·25	3·16	1·7	4·79	2·5	10·00	5·0	100·00	7·5	1000·00	10·0	10,000·0	12·5	100,000	15·0	1,000,000

Distance and Magnitude:—Increase of distance ("Dist.") for a difference ("Diff.") of 1 to 20 magnitudes. Thus a Mag. 5 star placed 100 times further away would be 10 magnitudes fainter, or Mag. 15. (Mag.-diff. × 0·2 = logarithm of distance-increase).

Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.	Diff.	Dist.
½	1·26	2	2·51	4	6·31	6	15·85	8	39·81	10	100·0	12	251·2	14	631·0	16	1585	18	3981	19	6310
1	1·59	3	3·98	5	10·00	7	25·12	9	63·10	11	158·5	13	398·1	15	1000	17	2512	18½	5012	19½	7943
																				20	10000

Mean Refraction *(Bessel)*.—For 50° F. (10° C.), and barometer 29·6 ins. (752 mm). **Other Temperatures, add** 1% per 5° F. (2·8° C.) if lower, deduct if higher : **Pressures,** add 3½% per inch (25·4 mm.) if higher, deduct if lower; = abt. 1% ☿ ½ inch, or ☿ 6mm.

Alt.	Refraction.	Alt.	Refraction.	Alt.	Refraction.	Alt.	Refraction.	Alt.	Refraction.	Alt.	Refraction.	Alt.	Refraction.	Alt.	Refraction.	Alt.	Refraction.	Alt.	Refraction.
0°	34′ 54″	¾°	26′ 35″	3°	14′ 15″	6°	8′ 23″	9°	5′ 49″	12°	4′ 25″	15°	3′ 32″	25°	2′ 3″	40°	1′ 9″	65°	0′ 27″
¼	31 50	1	24 25	4	11 39	7	7 20	10	5 16	13	4 5	16	3 19	30	1 40	45	0 58	80	0 10
½	29 3	2	18 9	5	9 47	8	6 30	11	4 49	14	3 47	20	2 37	35	1 22	50	0 48	90	0 0

Light-Years equivalent to Parsecs.—Multiples by 10, 100, shift point one, two, places to rt. P., parsecs; L/y., light-yrs.

P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.	P.	L/y.
1	3·259	6	19·554	11	35·85	16	52·14	21	68·44	26	84·73	31	101·03	36	117·32	41	133·62	46	149·91	60	195·54
2	6·518	7	22·813	12	39·11	17	55·40	22	71·70	27	87·99	32	104·29	37	120·58	42	136·88	47	153·17	70	228·13
3	9·777	8	26·072	13	42·37	18	58·66	23	74·96	28	91·25	33	107·55	38	123·84	43	140·14	48	156·43	80	260·72
4	13·036	9	29·331	14	45·63	19	61·92	24	78·22	29	94·51	34	110·81	39	127·10	44	143·40	49	159·69	90	293·31
5	16·295	10	32·590	15	48·89	20	65·18	25	81·48	30	97·77	35	114·07	40	130·36	45	146·66	50	162·95	100	325·90

Parsecs and Light-years equivalent to any parallax (π). ·0001, ·0002, &c., move parsec or light-yr. decimal one place to rt.

π	Parsecs	Light-yrs.	π	Parsecs	Light-yrs.	π	Parsecs	Light-y.	π	Parsecs	Light-y.	π	Parsecs	Light-y.	π	Parsecs	Light-y.
·001″	1000	3259·0	·021″	47·62	155·19	·041″	24·39	79·49	·061″	16·39	53·43	·081″	12·35	40·24	·12″	8·33	27·16
·002	500·0	1629·5	·022	45·45	148·14	·042	23·81	77·61	·062	16·13	52·57	·082	12·20	39·75	·14	7·14	23·28
·003	333·3	1086·3	·023	43·48	141·69	·043	23·26	75·79	·063	15·87	51·74	·083	12·05	39·26	·15	6·67	21·73
·004	250·0	814·74	·024	41·67	135·79	·044	22·73	74·06	·064	15·63	50·92	·084	11·90	38·80	·16	6·25	20·37
·005″	200·0	651·79	·025″	40·00	130·36	·045″	22·22	72·43	·065″	15·38	50·14	·085″	11·76	38·34	·18″	5·56	18·11
·006	166·7	543·16	·026	38·46	125·35	·046	21·74	70·84	·066	15·15	49·39	·086	11·63	37·90	·20	5·00	16·30
·007	142·9	465·56	·027	37·04	120·70	·047	21·28	69·34	·067	14·93	48·64	·087	11·49	37·46	·22	4·55	14·81
·008	125·0	407·37	·028	35·71	116·39	·048	20·83	67·91	·068	14·71	47·93	·088	11·36	37·03	·24	4·17	13·58
·009	111·1	362·11	·029	34·48	112·38	·049	20·41	66·51	·069	14·49	47·24	·089	11·24	36·62	·25	4·00	13·04
·010″	100·0	325·90	·030″	33·33	108·63	·050″	20·00	65·18	·070″	14·29	46·56	·090″	11·11	36·21	·26″	3·85	12·54
·011	90·91	296·27	·031	32·26	105·13	·051	19·61	63·90	·071	14·08	45·90	·091	10·99	35·82	·28	3·57	11·64
·012	83·33	271·58	·032	31·25	101·84	·052	19·23	62·68	·072	13·89	45·27	·092	10·87	35·42	·30	3·33	10·86
·013	76·92	250·69	·033	30·30	98·76	·053	18·87	61·49	·073	13·70	44·65	·093	10·75	35·04	·35	2·86	9·31
·014	71·43	232·79	·034	29·41	95·85	·054	18·52	60·35	·074	13·51	44·04	·094	10·64	34·67	·40	2·50	8·15
·015″	66·67	217·27	·035″	28·57	93·11	·055″	18·18	59·25	·075″	13·33	43·45	·095″	10·53	34·31	·45″	2·22	7·24
·016	62·50	203·69	·036	27·78	90·53	·056	17·86	58·20	·076	13·16	42·88	·096	10·42	33·95	·50	2·00	6·52
·017	58·82	191·70	·037	27·03	88·08	·057	17·54	57·17	·077	12·99	42·33	·097	10·31	33·60	·55	1·82	5·92
·018	55·56	181·05	·038	26·32	85·76	·058	17·24	56·20	·078	12·82	41·78	·098	10·20	33·26	·60	1·67	5·43
·019	52·63	171·53	·039	25·64	83·56	·059	16·95	55·23	·079	12·66	41·26	·099	10·10	32·92	·65	1·54	5·01
·020″	50·00	162·95	·040″	25·00	81·47	·060″	16·62	54·32	·080″	12·50	40·74	·100″	10·00	32·59	·70	1·43	4·66
															·75″	1·33	4·35

* Mean opposition magnitudes : star magnitudes only are from the H.R.

Parsecs or Light-years equivalent to Km/seconds Velocities, at 500 km/seconds (310·69 mile/secs.) per megaparsec; or 153·42 km./secs. (95·33 mile/secs.) per megalight-year. For per km/ or mile/ day, or year, multiply by 86,400, or 31½ millions.

km/ secs.	Millions of: Pcs.	L/y.	km/ secs.	Millions of: Pcs.	L/y.	km/ secs.	Millions of:— Pcs.	L/y.	km/ secs.	Millions of— Pcs.	Ly.	km/ secs.	Millions of:— Pcs.	L/y.	km/ secs.	Millions of:— Pcs.	L/y.	km/ secs.	Millions of:— Parsecs	Light-yrs
100	0·2	0·7	1500	3·0	9·8	4500	9·0	29·3	9000	18·0	58·7	15,000	30·0	97·8	21,000	42·0	136·9	35,000	70·0	228·1
200	0·4	1·3	2000	4·0	13·0	5000	10·0	32·6	10,000	20·0	65·2	16,000	32·0	104·3	22,000	44·0	143·4	40,000	80·0	260·7
300	0·6	2·0	2500	5·0	16·3	5500	11·0	35·8	11,000	22·0	71·7	17,000	34·0	110·8	23,000	46·0	149·9	45,000	90·0	293·3
400	0·8	2·6	3000	6·0	19·6	6000	12·0	39·1	12,000	24·0	78·2	18,000	36·0	117·3	24,000	48·0	156·4	50,000	100·0	325·9
500	1·0	3·3	3500	7·0	22·8	7000	14·0	45·6	13,000	26·0	84·7	19,000	38·0	123·8	25,000	50·0	163·0	55,000	110·0	358·5
1000	2·0	6·5	4000	8·0	26·1	8000	16·0	52·1	14,000	28·0	91·3	20,000	40·0	130·4	30,000	60·0	195·5	60,000	120·0	391·1

Kilometres converted into Miles:—Multiples by 10, 100, 1000, shift decimal point one, two, three places to the right.

km.	=miles	km.	=miles	km.	=miles	km.	=miles	km.	=miles	km.	=miles	km.	=miles	km.	=miles	km.	=miles	km.	=miles	km.	=miles
1	0·621	6	3·728	11	6·835	16	9·942	21	13·049	26	16·156	31	19·263	36	22·369	41	25·476	46	28·583	60	37·282
2	1·243	7	4·350	12	7·456	17	10·563	22	13·670	27	16·777	32	19·884	37	22·991	42	26·098	47	29·204	70	43·496
3	1·864	8	4·971	13	8·078	18	11·185	23	14·292	28	17·398	33	20·505	38	23·612	43	26·719	48	29·826	80	49·710
4	2·485	9	5·592	14	8·699	19	11·806	24	14·913	29	18·020	34	21·127	39	24·233	44	27·340	49	30·447	90	55·923
5	3·107	10	6·214	15	9·321	20	12·427	25	15·534	30	18·641	35	21·748	40	24·855	45	27·962	50	31·069	100	62·137

Centigrade Degrees converted into Degrees Fahr. (nearest 100, after 1000°). For any temperature (under 0°, use *lower* + or −: °F. = °C. × 9 ÷ 5 ± 32; °C = (°F. ∓ 32) × 5 ÷ 9. *For the °K equivalent*:—**If above 0° C.** *add*, **if below** subtract from, 273° C. **10 C.° = 18 F.°**

°C.	=°F.	°C.	=°F.	°C.	=°F.	°C.	=°F.	°C.	=°F.	°C.	=°F.	°C.	=°F.	°C.	=°F.	°C.	=°F.	°C.	=°F.	°C.	=°F.
−273	−460	−80	−112	10°	50	110°	230	210°	410	310°	590	410°	770	750°	1382	5500°	9900	11000°	19800	21000°	37800
250	418	70	94	20	68	120	248	220	428	320	608	420	788	1000	1832	6000	10800	12000	21600	22000	39600
200	328	60	76	30	86	130	266	230	446	330	626	430	806	1500	2700	6500	11700	13000	23400	23000	41400
150	238	50	58	40	104	150	284	240	464	340	644	440	824	2000	3600	7000	12600	14000	25200	24000	43200
140	220	40	40	50	122	150	302	250	482	350	662	450	842	2500	4500	7500	13500	15000	27000	25000	45000
130	202	30	22	60	140	160	320	260	500	360	680	460	860	3000	5400	8000	14400	16000	28800	26000	46800
120	184	20	−4	70	158	170	338	270	518	370	698	470	878	3500	6300	8500	15300	17000	30600	28000	50400
110	166	−10	+14	80	176	180	356	280	536	380	716	480	896	4000	7200	9000	16200	18000	32400	30000	54000
100	148	0	32	90	194	190	374	290	554	390	734	490	914	4500	8100	9500	17100	19000	34200	35000	63000
−90	−130	+5	+41	100	212	200	392	300	572	400	752	500	932	5000	9000	10000	18000	20000	36000	40000	72000

'K' Degrees converted into Centigrade and Fahrenheit Degrees (to nearest 100°, after 1000°). **100 K.° = 100 C.° = 180 F.°**

°K.	=°C.	=°F.	°K.	=°C.	=°F.	°K.	=°C.	=°F.	°K.	=°C.	=°F.	°K.	=°C.	=°F.	°K.	=°C.	=°F.	°K.	=°C.	=°F.
0	−273	−460	500	227	441	4000	3700	6700	7500	7200	13,000	14,000	13,700	24,700	25,000	24,700	44,500			
100	−173	−280	1000	727	1341	4500	4200	7600	8000	7700	13,900	15,000	14,700	26,500	30,000	29,700	53,500			
200	−73	−99	1500	1200	2200	5000	4700	8500	9000	8700	15,700	16,000	15,700	28,300	35,000	34,700	62,500			
255	−18	0	2000	1700	3100	5500	5200	9400	10,000	9700	17,500	17,000	16,700	30,100	40,000	39,700	71,500			
273	0	+32	2500	2200	4000	6000	5700	10,300	11,000	10,700	19,300	18,000	17,700	31,900	45,000	44,700	80,500			
300	+27	+81	3000	2700	4900	6500	6200	11,200	12,000	11,700	21,100	19,000	18,700	33,700	50,000	49,700	89,500			
400	+127	+261	3500	3200	5800	7000	6700	12,100	13,000	12,700	22,900	20,000	19,700	35,500	60,000	59,700	107,500			

The Greek Alphabet. The small letters are on the left, the capitals on the right.

Letter	Name		Letter	Name		Letter	Name		Letter	Name		Letter	Name		Letter	Name	
α	Alpha	... A	ϵ	Epsilon	... E	ι	Iota	... I	ν	Nu	... N	ρ	Rho	... P	ϕ	Phi	... Φ
β	Beta	... B	ζ	Zeta	... Z	κ	Kappa	... K	ξ	Xi	... Ξ	σ	Sigma	... Σ	χ	Chi	... X
γ	Gamma	... Γ	η	Eta	... H	λ	Lambda	... Λ	o	Omicron	... O	τ	Tau	... T	ψ	Psi	... Ψ
δ	Delta	... Δ	θ	Theta	... Θ	μ	Mu	... M	π	Pi	... Π	υ	Upsilon	... Υ	ω	Omega	... Ω

Degrees equivalent to Right Ascension Hours and Minutes:— See Table on page 43. **Decimals of a Degree,** p. xv.

No. of Seconds of Arc: in 360°, 1,296,000″; **in 1°,** 3600″. **No. of Seconds of Time: in 1 day,** 86,400 sec.; **in 1 hour,** 3600s.

Velocities of Gases in Km./sec. *H*, hydrogen; *He*, helium; H_2O, water; *N*, nitrogen; *O*, oxygen; CO_2, carbonic acid.

	−200°C.	−150°	−100°	−50°	0°C.	+50°	100°	200°	300°	400°
H.	0·95	1·33	1·46	1·66	**1·84**	2·00	2·15	2·42	2·67	2·89
He.	0·68	0·88	1·04	1·18	**1·31**	1·42	1·53	1·72	1·90	2·06
H_2O	0·32	0·42	0·49	0·56	**0·62**	0·67	0·72	0·82	0·90	0·97

	−200°	−150°	−100°	−50°	0°C.	+50°	+100°	200°	300°	400°
N.	0·25	0·33	0·39	0·44	**0·49**	0·53	0·57	0·64	0·71	0·77
O.	0·24	0·31	0·37	0·42	**0·46**	0·50	0·54	0·61	0·67	0·72
CO_2	0·20	0·26	0·31	0·35	**0·39**	0·42	0·46	0·51	0·57	0·61

Ionisation Potentials.—The second value is the voltage required to remove a second electron; it differs widely. Potassium, volts, 4·3, 22; Sodium, 5·1, 30; Lithium, 5·4, 68; Calcium, 6·1, 12; Titanium, 6·8, 14; Magnesium, 7·6, 15; Iron, 8·2, 13; Silicon, 8·2, 16; Sulphur, 10·3, ...; Carbon, 11·3, 24; Hydrogen, 13·5; Oxygen, 13·6, 35; Nitrogen, 14·2, 30; Helium, 24·4, 54 (see p. 24).

Sunset and Sunrise.—The time varies slightly from year to year, but the Sunset Table opposite will give the Apparent or True (Sundial) time of both Sunset or Sunrise within a few minutes, in both Northern and Southern latitudes.

To find the Mean Time equivalent, add or subtract the Equation of Time *(E)* given in small figures. A further correction is required for longitude, of 4 minutes for each degree W. or E. of the Standard meridian—added if W., subtracted if E.

Sunrise.—Subtract the time of Sunset from 12 hrs. 0 min., and adjust for Equation of Time, and longitude, as for Sunset. Thus sunrise on May 25, lat. 45°N., long. 4° W. of Std. meridian, is at 4·38 (12h. − 7h. 35m., − 3m. Equation, +16m. for longitude).

Earliest and Latest Sunrise and Sunset, in different N. Latitudes. There are two 'earliests' and 'latests' in low latitudes.

Latitude	0°	0°	10°	10°	20°	30°	35°	40°	45°	50°	55°	60°
Rising. Earliest:— a.m.	Nov. 4 5.40	May 16 5.53	May 30 5.37	Oct. 11 5.48	June 7 5.20	June 11 4.58	June 14 4.45	June 15 4.30	June 17 4.12	June 18 3.50	June 19 3.20	June 19 2.35
„ Latest:— a.m.	Feb. 12 6.11	July 28 6.03	Aug. 24 5.51	Jan. 27 6.23	Jan. 18 6.38	Jan. 11 6.57	Jan. 8 7.09	Jan. 6 7.22	Jan. 3 7.39	Jan. 1 7.59	Dec. 29 8.26	Dec. 28 9.04
Setting. Earliest— p.m.	Nov. 2 5.47	May 14 6.0	Nov. 17 5.35	Apr. 10 6.10	Nov. 26 5.19	Dec. 3 5.0	Dec. 6 4.48	Dec. 8 4.35	Dec. 11 4.18	Dec. 13 3.58	Dec. 15 3.32	Dec. 17 2.53
„ Latest:— p.m.	Feb. 10 6.18	July 25 6.10	July 12 6.25	Mar. 17 6.11	July 5 6.43	July 2 7.5	June 30 7.18	June 28 7.33	June 27 7.51	June 26 8.13	June 25 8.43	June 24 9·28

Sun's Longitude, Right Ascension, and Declination, at 0h. Intermediate dates: for R.A. add 4 minutes ♆ day.

Date	Long.	R.A.	Dec.	Date	Long.	R.A.	Dec.	Date	Long.	R.A.	Dec.	Date	Long.	R.A.	Dec.	Date	Long.	R.A.	Dec.
Jan. 1	280°	...	−23°	Mar. 5	344°	23h	−6°	May 22	60°	...	+20°	Aug. 2	130°	...	+18°	Oct. 13	200°	...	−7°
„ 5	284	19h	23	„ 11	350	...	− 4	„ 23	61	4h	20	„ 5	132	9h	17	„ 24	210	...	11
„ 11	290	...	22	„ 21	0	24h	0	June 1	70	...	22	„ 13	140	...	15	„ 29	215	14h	13
„ 18	297	20h	21	„ 31	10	...	+ 4	„ 7	76	5h	23	„ 21	147	10h	12	Nov. 3	220	...	15
„ 20	300	...	20	Apr. 6	16	1h	6	„ 11	80	...	23	„ 24	150	...	11	„ 10	227	15h	17
„ 30	310	...	18	„ 10	20	...	8	„ 22	90	6h	23½	Sept. 3	160	...	8	„ 13	230	...	18
Feb. 2	312	21h	17	„ 20	30	...	11	July 2	100	...	23	„ 7	163	11h	6	„ 23	240	...	20
„ 9	320	...	15	„ 23	32	2h	12	„ 6	103	7h	23	„ 13	170	...	+4	„ 25	242	16h	21
„ 17	327	22h	12	May 1	40	...	15	„ 13	110	...	22	„ 24	180	12h	0	Dec. 3	250	...	22
„ 19	330	...	12	„ 8	47	3h	17	„ 21	118	8h	21	Oct. 3	190	...	−4	„ 8	255	17h	23
Mar. 1	340	...	−8°	May 11	50	...	+18°	July 23	120	...	+20°	Oct. 10	196	13h	−6°	„ 12	260	...	−23
																Dec. 22	270	18h	23½

Equation of Time.—Mean Time ± the minutes in the Table = True or 'sundial' time. Clock before Sun −; after, +.

Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.	Date	Eqn.
Jan. 1	−3m.	Jan. 29	−13m.	Mar. 20	−8m.	Apr. 25	+2m.	Jun. 24	−2m.	Aug. 22	−3m.	Sep. 22	+7m.	Nov. 4	+16⅓m.	Dec. 11	+7m.		
„ 3	4	Feb. 4	14	„ 23	7	May 2	3	„ 29	3	„ 26	2	„ 25	8	„ 11	16m.	„ 13	6		
„ 5	5	„ 12	14⅓	„ 26	6	„ 7	3½	July 4	4	„ 29	−1	„ 28	9	„ 18	15	„ 16	5		
„ 7	6	„ 20	14	„ 29	5	„ 15	3¾	„ 10	5	Sep. 2	0	Oct. 1	10	„ 22	14	„ 18	4		
Jan. 9	7	„ 24	13½	Apr. 2	4	„ 23	3½	„ 14	5½	„ 5	+1	„ 4	11	„ 26	13	Dec. 20	3		
„ 12	8	„ 27	13	„ 5	3	„ 28	3	„ 19	6	„ 8	2	„ 7	12	„ 29	12	„ 22	2		
„ 15	9	Mar. 4	12	„ 8	2	Jun. 4	2	„ 27	6⅓	„ 11	3	„ 11	13	Dec. 1	11	„ 24	+1		
„ 18	10	„ 8	11	„ 12	−1	„ 10	+1	Aug. 5	6	„ 14	4	„ 15	14	„ 4	10	„ 26	0		
„ 21	11	„ 12	10	„ 16	0	„ 15	0	„ 13	5	„ 17	5	„ 20	15	„ 7	9	„ 28	−1		
Jan. 24	−12	Mar. 16	− 9	Apr. 20	+1m.	Jun. 19	−1m.	Aug. 18	−4m.	Sep. 19	+6m.	Oct. 27	+16	Dec. 9	+8	Dec. 30	−2m.		

Angular Distances on the Star Sphere.—The following approximations are convenient for rough estimates; others can easily be made up from the star charts: the degrees are those of a 'great circle,' as of Declination, or those on the Celestial equator.

½° = the angular diameter of the Moon (approx.).
1¼° = δ to ε Orionis: or β to λ Crucis „
2° = α to γ Aquilæ; or α to σ Scorpii. „
2½° = α to β Aquilæ; or α to δ Reticuli ... (approx.).
4° = α to β Canis Minoris; or α to β Crucis „
5° = α to β Ursæ Majoris; or α to β Centauri „

The Star Sphere contains 41,253 square degrees.

Approximate Galactic Longitude and Latitude of certain Stars:—

Long.	Lat.	Star
3°	+21°	α Ophiuchi
9°	+52°	α Coronæ
16°	−10°	α Aquilæ (*Altair*)
20°	+39°	ζ Herculis
31°	+12°	γ Lyræ
35°	+18°	α Lyræ (*Vega*)
46°	+ 1°	γ Cygni
52°	+ 1°	α Cygni (*Deneb*)
59°	+40°	η Draconis
65°	+65°	η Ursæ Maj.
79°	+41°	β Ursæ Min.
78°	+62°	ζ Ursæ Maj. (*Mizar*)
87°	+61°	ε Ursæ Maj.
88°	−81°	β Ceti
90°	+27°	α Ursæ Min. (*Polaris*)
91°	− 2°	γ Cassiopeiæ
98°	+60°	δ Ursæ Maj.
109°	+52°	α Ursæ Maj. (*Dubhe*)
121	+47°	υ Ursæ Maj.
130°	+ 6°	α Aurigæ (*Capella*)
132°	+64°	ψ Ursæ Maj.
135°	+12°	β Aurigæ
149°	−19°	α Tauri (*Aldebaran*)
155°	+24°	α Geminorum (*Castor*)
160°	+25°	β Geminorum (*Pollux*)
165°	−15°	γ Orionis (*Bellatrix*)
167°	− 7°	α Orionis (*Betelgeuse*)
177°	−24°	β Orionis (*Rigel*)
182°	+15°	α Canis Min. (*Procyon*)
195°	+50°	α Leonis (*Regulus*)
195°	− 8°	α Canis Maj. (*Sirius*)
205°	+66°	θ Leonis
210°	+30°	α Hydræ (*Alphard*)
210°	− 5°	η Canis Maj.
222°	+72°	β Leonis (*Denebola*)
228°	−25°	α Carinæ (*Canopus*)
230°	− 7°	γ Velorum
240°	+61°	β Virginis
250°	−13°	α Volantis
256°	−59°	α Eridani (*Achernar*)
268°	− 1°	α Crucis
279°	+ 1°	β Centauri
284°	− 1°	α Centauri
285°	+50°	α Virginis (*Spica*)
289°	−16°	α Trianguli Aus.
300°	− 9°	ζ Aræ
313°	−59°	β Gruis
317°	−54°	α Gruis
320°	+14°	α Scorpii (*Antares*)
321°	+22°	β Scorpii
327°	−11°	ε Sagittarii
343°	+68°	α Boötis (*Arcturus*)
348°	−66°	α Pisc. A. (*Fomalhaut*)
355°	+ 4°	η Serpentis

Apparent (Sundial) Time of Sunset.—To obtain Mean Time of Sunset, see opposite. *E.* = Equation of Time.

Northern Latitudes				0°	10°	20°	30°	35°	40°	45°	50°	52°	54°	56°	58°	60°	Southern Latitudes			
Date	*E.*	Date	*E.*	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	Date	*E.*	Date	*E.*
Dec. 21	−2	Dec. 21	−2	6 04	5 46	5 28	5 06	4 54	4 40	4 23	4 02	3 52	3 41	3 28	3 14	2 56	Jun. 21	+1	Jun. 21	+1
„ 24	−1	„ 19	3	6 04	5 47	5 28	5 07	4 55	4 40	4 23	4 03	3 53	3 42	3 29	3 14	2 57	„ 24	2	„ 18	1
„ 27	+1	„ 16	5	6 04	5 47	5 28	5 07	4 55	4 40	4 24	4 03	3 54	3 43	3 30	3 15	2 58	„ 27	3	„ 16	0
„ 30	2	„ 14	6	6 04	5 47	5 28	5 07	4 55	4 41	4 25	4 04	3 55	3 44	3 31	3 16	2 59	„ 30	3	„ 13	0
Jan. 1	3	„ 11	7	**6 04**	**5 47**	**5 29**	**5 08**	**4 56**	**4 42**	**4 26**	**4 05**	**3 56**	**3 45**	**3 33**	**3 18**	**3 01**	July 3	4	„ 10	−1
„ 4	5	„ 8	8	6 04	5 47	5 29	5 08	4 57	4 43	4 27	4 07	3 57	3 46	3 35	3 21	3 04	„ 6	4	„ 7	2
„ 7	6	„ 5	10	6 04	5 47	5 30	5 09	4 58	4 44	4 28	4 09	4 00	3 49	3 38	3 24	3 08	„ 9	5	June 3	2
„ 10	7	Dec. 2	11	6 04	5 48	5 31	5 11	4 59	4 46	4 30	4 12	4 03	3 53	3 41	3 28	3 13	„ 12	5	May 31	3
„ 13	8	Nov. 29	12	6 04	5 48	5 32	5 12	5 01	4 48	4 33	4 15	4 06	3 56	3 45	3 33	3 18	„ 15	6	„ 28	3
„ 16	10	„ 26	13	**6 04**	**5 48**	**5 32**	**5 13**	**5 02**	**4 50**	**4 36**	**4 17**	**4 09**	**3 59**	**3 49**	**3 37**	**3 23**	„ 19	6	„ 25	3
„ 19	11	„ 23	14	6 04	5 49	5 33	5 15	5 04	4 52	4 39	4 21	4 13	4 03	3 54	3 42	3 29	„ 22	6	„ 22	4
„ 22	11	„ 20	15	6 04	5 50	5 34	5 17	5 07	4 55	4 42	4 25	4 18	4 08	3 59	3 48	3 36	„ 25	6	„ 19	4
„ 25	12	„ 17	15	6 04	5 50	5 35	5 19	5 09	4 58	4 45	4 29	4 22	4 14	4 05	3 54	3 42	„ 28	6	„ 15	4
„ 28	13	„ 14	16	6 04	5 51	5 36	5 20	5 11	5 01	4 48	4 33	4 26	4 19	4 10	4 00	3 49	„ 31	6	„ 12	4
„ 31	13	„ 11	16	**6 04**	**5 51**	**5 38**	**5 22**	**5 14**	**5 04**	**4 52**	**4 38**	**4 31**	**4 24**	**4 16**	**4 07**	**3 56**	Aug. 3	+6	„ 9	4
Feb. 3	+14	„ 8	−16	6 04	5 52	5 39	5 24	5 16	5 07	4 56	4 43	4 36	4 30	4 22	4 13	4 04	„ 7	6	„ 6	3
„ 6	14	„ 5	16	6 04	5 52	5 40	5 27	5 19	5 10	5 00	4 48	4 42	4 36	4 28	4 20	4 12	„ 10	5	May 3	3
„ 9	14	Nov. 2	16	6 04	5 53	5 42	5 29	5 22	5 14	5 04	4 53	4 48	4 42	4 35	4 27	4 19	„ 13	5	Apr. 30	3
„ 12	14	Oct. 30	16	6 04	5 54	5 44	5 32	5 25	5 18	5 09	4 58	4 53	4 48	4 42	4 35	4 27	„ 16	4	„ 27	2
„ 15	14	„ 27	16	**6 04**	**5 55**	**5 45**	**5 34**	**5 28**	**5 21**	**5 13**	**5 03**	**4 59**	**4 54**	**4 48**	**4 42**	**4 35**	„ 19	4	„ 24	2
„ 18	14	„ 24	16	6 04	5 55	5 46	5 36	5 31	5 24	5 17	5 08	5 04	5 00	4 55	4 49	4 43	„ 22	3	„ 21	−1
„ 21	14	„ 21	15	6 03	5 56	5 48	5 39	5 34	5 28	5 21	5 14	5 10	5 06	5 01	4 56	4 51	„ 26	2	„ 18	0
„ 24	13	„ 18	15	6 03	5 56	5 50	5 42	5 37	5 32	5 26	5 19	5 16	5 13	5 08	5 04	4 59	„ 29	+1	„ 15	0
„ 27	13	„ 15	14	6 03	5 57	5 51	5 44	5 40	5 36	5 31	5 25	5 22	5 19	5 15	5 11	5 07	Sept. 1	0	„ 12	+1
Mar. 2	12	„ 12	−13	**6 03**	**5 58**	**5 53**	**5 47**	**5 43**	**5 40**	**5 36**	**5 30**	**5 28**	**5 26**	**5 22**	**5 19**	**5 15**	„ 4	−1	„ 9	2
„ 5	+12	„ 9	12	6 03	5 59	5 54	5 49	5 46	5 43	5 40	5 35	5 33	5 32	5 29	5 26	5 23	„ 7	2	„ 5	3
„ 8	11	„ 6	12	6 03	6 00	5 56	5 52	5 50	5 47	5 45	5 41	5 39	5 38	5 36	5 34	5 32	„ 10	3	Apr. 2	4
„ 11	10	Oct. 3	11	6 03	6 01	5 58	5 55	5 54	5 51	5 50	5 47	5 45	5 45	5 43	5 42	5 40	„ 13	4	Mar. 30	5
„ 14	10	Sep. 30	10	6 03	6 01	5 59	5 57	5 57	5 55	5 54	5 52	5 51	5 51	5 50	5 49	5 48	„ 16	5	„ 27	6
„ 17	9	„ 27	9	**6 03**	**6 02**	**6 01**	**6 00**	**6 00**	**5 59**	**5 59**	**5 58**	**5 58**	**5 57**	**5 57**	**5 57**	**5 56**	„ 19	6	„ 25	6
„ 20	8	„ 24	8	6 03	6 03	6 03	6 03	6 03	6 03	6 03	6 04	6 04	6 04	6 04	6 04	6 04	„ 22	7	„ 22	7
„ 23	7	„ 21	7	6 03	6 04	6 05	6 06	6 06	6 07	6 08	6 09	6 10	6 11	6 11	6 12	6 13	„ 25	8	„ 19	8
„ 26	6	„ 18	5	6 03	6 05	6 07	6 09	6 10	6 11	6 13	6 15	6 16	6 17	6 18	6 19	6 21	„ 28	−9	„ 16	9
„ 29	5	„ 15	4	6 03	6 06	6 08	6 11	6 13	6 15	6 18	6 21	6 22	6 24	6 25	6 27	6 29	Oct. 2	10	„ 13	10
Apr. 1	+4	„ 11	3	**6 03**	**6 06**	**6 10**	**6 14**	**6 16**	**6 19**	**6 22**	**6 26**	**6 28**	**6 30**	**6 32**	**6 35**	**6 38**	„ 5	11	„ 9	11
„ 4	3	„ 8	2	6 03	6 07	6 12	6 17	6 20	6 23	6 27	6 32	6 34	6 37	6 39	6 43	6 46	„ 8	12	„ 6	12
„ 7	2	„ 5	−1	6 03	6 08	6 13	6 20	6 23	6 27	6 32	6 38	6 40	6 44	6 46	6 50	6 54	„ 11	13	Mar. 3	12
„ 10	2	Sept. 2	0	6 03	6 08	6 14	6 22	6 26	6 31	6 36	6 43	6 46	6 50	6 53	6 57	7 02	„ 13	13	Feb. 28	+13
„ 13	+1	Aug. 30	+1	6 03	6 09	6 16	6 24	6 29	6 35	6 41	6 48	6 52	6 56	7 00	7 05	7 10	„ 16	14	„ 25	13
„ 16	0	„ 27	2	**6 03**	**6 10**	**6 18**	**6 27**	**6 32**	**6 39**	**6 46**	**6 54**	**6 58**	**7 02**	**7 07**	**7 12**	**7 18**	„ 19	15	„ 22	14
„ 19	−1	„ 24	3	6 03	6 11	6 20	6 30	6 35	6 43	6 50	7 00	7 04	7 09	7 14	7 20	7 26	„ 22	15	„ 20	14
„ 22	1	„ 21	3	6 03	6 12	6 21	6 32	6 38	6 46	6 54	7 05	7 09	7 15	7 20	7 27	7 34	„ 25	16	„ 17	14
„ 25	2	„ 18	4	6 04	6 13	6 23	6 35	6 41	6 50	6 59	7 10	7 15	7 21	7 27	7 34	7 42	„ 28	16	„ 14	14
„ 28	2	„ 15	5	6 04	6 13	6 24	6 37	6 44	6 53	7 03	7 15	7 20	7 27	7 33	7 41	7 50	„ 31	16	„ 11	14
May 1	−3	„ 12	+5	**6 04**	**6 14**	**6 26**	**6 40**	**6 47**	**6 57**	**7 07**	**7 20**	**7 26**	**7 33**	**7 40**	**7 49**	**7 58**	Nov. 3	−16	„ 8	14
„ 4	3	„ 9	6	6 04	6 15	6 27	6 42	6 50	7 00	7 11	7 25	7 31	7 39	7 47	7 56	8 06	„ 6	16	„ 5	14
„ 7	3	„ 6	6	6 04	6 15	6 28	6 44	6 53	7 03	7 15	7 30	7 36	7 44	7 53	8 02	8 14	„ 9	16	Feb. 2	14
„ 10	4	Aug. 3	6	6 04	6 16	6 31	6 46	6 56	7 07	7 19	7 35	7 42	7 50	7 59	8 09	8 22	„ 12	16	Jan. 31	13
„ 13	4	July 31	6	6 04	6 17	6 32	6 48	6 58	7 10	7 23	7 39	7 47	7 55	8 05	8 16	8 29	„ 15	15	„ 28	13
„ 16	4	„ 28	6	**6 04**	**6 18**	**6 33**	**6 50**	**7 01**	**7 12**	**7 26**	**7 43**	**7 52**	**8 00**	**8 11**	**8 22**	**8 36**	„ 17	15	„ 25	12
„ 19	4	„ 25	6	6 04	6 18	6 34	6 52	7 03	7 15	7 30	7 47	7 56	8 05	8 16	8 28	8 43	„ 20	15	„ 22	11
„ 22	4	„ 22	6	6 04	6 19	6 35	6 54	7 05	7 18	7 33	7 51	8 00	8 10	8 21	8 34	8 50	„ 23	14	„ 19	11
„ 25	3	„ 19	6	6 04	6 19	6 36	6 55	7 06	7 20	7 35	7 54	8 04	8 14	8 26	8 39	8 56	„ 26	13	„ 16	10
„ 28	3	„ 16	6	6 04	6 20	6 37	6 57	7 08	7 22	7 38	7 58	8 08	8 18	8 30	8 44	9 01	„ 29	12	„ 14	9
„ 31	3	„ 13	5	**6 04**	**6 20**	**6 38**	**6 58**	**7 10**	**7 24**	**7 41**	**8 01**	**8 11**	**8 22**	**8 34**	**8 49**	**9 07**	Dec. 2	11	„ 11	8
June 3	−2	„ 10	5	6 04	6 20	6 38	6 59	7 11	7 26	7 42	8 03	8 14	8 25	8 38	8 53	9 12	„ 5	10	„ 8	6
„ 6	2	„ 7	5	6 04	6 21	6 39	7 00	7 13	7 27	7 44	8 05	8 16	8 28	8 41	8 57	9 16	„ 7	−9	„ 5	5
„ 9	−1	„ 4	4	6 04	6 21	6 39	7 01	7 13	7 28	7 46	8 07	8 18	8 30	8 44	9 00	9 19	„ 10	8	Jan. 2	+4
„ 12	−1	July 1	3	6 04	6 21	6 40	7 02	7 14	7 29	7 47	8 09	8 20	8 32	8 46	9 03	9 22	„ 13	6	Dec. 31	3
„ 15	0	Jun. 28	3	**6 04**	**6 21**	**6 40**	**7 02**	**7 15**	**7 30**	**7 48**	**8 10**	**8 21**	**8 33**	**8 48**	**9 04**	**9 24**	„ 16	5	„ 28	+1
„ 18	+1	„ 25	2	6 04	6 21	6 40	7 02	7 15	7 30	7 48	8 11	8 22	8 34	8 48	9 05	9 26	„ 19	3	„ 25	0
Jun. 21	+1	Jun. 21	+1	6 04	6 22	6 41	7 03	7 16	7 31	7 49	8 12	8 23	8 35	8 49	9 06	9 27	Dec. 21	−2	Dec. 21	−2

Duration of Twilight (Table I).—See Note on page 38. (For fuller Tables, see *Nautical Almanac*).

Latitude,	0°	10°	20°	30°	40°	45°	50°	55°	60°
Winter Solstice	1h 16m	1h 16m	1h 19m	1h 25m	1h 38m	1h 47m	1h 59m	2h 17m	2h 46m
Equinoxes ...	1 9	1 10	1 13	1 19	1 30	1 39	1 50	2 4	2 25
Summer Solstice	1 15	1 18	1 25	1 36	2 03	2 33	Lasts from	Sunset to	Sunrise.
Apex of glow above horizon, 1 hr. after sunset, Dec. 21, *about*	7°		8°		9°		10°		12°

Semi-diurnal Arcs (II), or Time between Rising or Setting, and Culmination. (Refraction not allowed for).

N. Hemisphere observers read the star's N. or S. Declination at the *top* of the column; those in the S. Hemisphere, at the *foot*.

Observ. Lat.	N. Hemisphere:—STARS WITH NORTH DECLINATION. 30°	25°	20°	15°	10°	5°	0°	Observer's Lat.	N. Hemisphere:—STARS WITH S. DECLINATION. 5°	10°	15°	20°	25°	30°	Observ. Lat.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	
5°	6 11	6 8	6 7	6 5	6 4	6 2	6 0	5°	5 58	5 56	5 55	5 53	5 52	5 49	5°
10	6 23	6 19	6 15	6 11	6 7	6 4	6 0	10	5 56	5 53	5 49	5 45	5 41	5 37	10
15	6 36	6 29	6 22	6 16	6 11	6 5	6 0	15	5 55	5 49	5 44	5 38	5 31	5 24	15
20	6 49	6 39	6 30	6 22	6 15	6 7	6 0	20	5 53	5 45	5 38	5 30	5 21	5 11	20
25	7 2	6 49	6 39	6 29	6 19	6 9	6 0	25	5 51	5 41	5 31	5 21	5 11	4 58	25
30	7 19	7 2	6 49	6 36	6 23	6 12	6 0	30	5 48	5 37	5 24	5 11	4 58	4 41	30
35	7 35	7 16	6 59	6 43	6 28	6 14	6 0	35	5 46	5 32	5 17	5 1	4 44	4 25	35
40	7 55	7 32	7 11	6 52	6 34	6 17	6 0	40	5 43	5 26	5 8	4 49	4 28	4 5	40
45	8 18	7 51	7 25	7 2	6 41	6 20	6 0	45	5 40	5 19	4 58	4 35	4 9	3 42	45
50	8 53	8 15	7 43	7 14	6 49	6 24	6 0	50	5 36	5 11	4 46	4 17	3 45	3 7	50
55	9 39	8 47	8 5	7 30	6 58	6 29	6 0	55	5 31	5 2	4 30	3 55	3 13	2 21	55
60°	11 22	9 35	8 36	7 51	7 11	6 35	6 0	60°	5 25	4 49	4 9	3 24	2 25	0 38	60°
	S. Hemisphere:—STARS with SOUTH DECLINATION.								S. Hemisphere:—STARS with N. DECLINATION.						

Rising or Setting of Stars, &c.—From the R.A., find culmination-time (Table III), then for *Rising* Subtract, for *Setting* Add the semi-diurnal arc for the Dec. and observer's latitude. *Ex.* Rising of Leo on Nov. 13, in lat. 55 °N.; R.A. 10h., Dec. 20° N.?

On Nov. 14 (after midnight, 13th), as R.A. 9½ h. souths at 6 a.m., 10 h. souths at 6.30 a.m. Semi-diurnal arc for Dec. 20° N. and 55° N. is 8h. 5m., which subtracted from 6.30 a.m. gives 10.25 p.m. on Nov. 13th as the rising-time of Leo.

When does Mars rise on Mar. 28 in lat. 45° N.?; R.A. 13½h., Dec. 5° S. *(a)* Proceed as above. Or *(b)* Find in the *N.A.* the time of meridian passage on Mar. 28, say 1 a.m. (29th), from which subtract the semi-diurnal arc 5 h. 40 m. Answer, 7.20 p.m.

To find when a Star is on the Meridian.—(The R.A. Central Meridian of each Chart is given at the side).

When will the constellation Taurus be south at 10 p.m.? From the Index of Constellations (last page) Taurus is in Map 5: the central meridian of Taurus is R.A. 4 h. (see also at side). In Table III below, Sidereal Time, in the column headed 10 p.m., and in line with R.A. 4h., is the date required, Dec. 21.

What constellations are in the south at 8 p.m. on March 22nd? In Table III find March 22; in the column headed 8 p.m., in same line, is the answer R.A. 8 h., contained in Maps 7-8:—Gemini, Cancer, &c.

When will R.A. 6h. culminate on March 7? *Answer* (Table III), 7 p.m.—March 7 line, above R.A. 6h.

Central Maps	Meridian = R.A.
3-4	24 h.
5-6	4 h.
7-8	8 h.
9-10	12 h.
11-12	16 h.
13-14	20 h.

Sidereal Time (III), or Hour of R.A. on the Meridian.—If time is after midnight, add 1 day to the date at the side.

Intermediate Dates. Add to the R.A. for the previous date the requisite No. of minutes from the 7- or 8-day-interval Table below.

7 Days Interval:—1 day	2 dys.	3 dys.	4 dys.	5 dys.	6 days.
Add minutes, 4 m.	9 m.	13 m.	17 m.	21 m.	26 m.

8 Days Interval. 1 day	2 dys.	3 dys.	4 dys.	5 dys.	6 dys.	7 dys.
Add minutes, 4 m.	8 m.	12 m.	15 m.	19 m.	23 m.	26 m.

Intermediate Minutes of Mean Time. Add the same No. of R.A. minutes to the previous R.A. hour. Thus Apr. 6 at 5.9 p.m. = R.A. 6 h. 9m.

Date	Hour of R.A. on the Meridian at:— 5 p.m.	6p.	7p.	8p.	9p.	10p.	11p.	12a.	1a.	2a.	3a.	4a.	5a.	6a.
Jan. 5	0h.	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10	11	12	13
13	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	1	2	3	4	5	6	7	8	9	10	11	12	13	14
31 28	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Feb. 5	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13	½	½	½	½	½	½	½	½	½	½	½	½	½	½
20	3	4	5	6	7	8	9	10	11	12	13	14	15	16
24 28	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Mar. 7	4	5	6	7	8	9	10	11	12	13	14	15	16	17
15	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	5	6	7	8	9	10	11	12	13	14	15	16	17	18
31 29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Apr. 6	6	7	8	9	10	11	12	13	14	15	16	17	18	19
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	7	8	9	10	11	12	13	14	15	16	17	18	19	20
30 29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
May 7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
15	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	9	10	11	12	13	14	15	16	17	18	19	20	21	22
31 30	½	½	½	½	½	½	½	½	½	½	½	½	½	½
June 6	10	11	12	13	14	15	16	17	18	19	20	21	22	23
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
30 22	11	12	13	14	15	16	17	18	19	20	21	22	23	0
Jun. 29	½	½	½	½	½	½	½	½	½	½	½	½	½	½

Date	Hour of R.A. on the Meridian at:— 5 p.m.	6p.	7p.	8p.	9p.	10p.	11p.	12a.	1a.	2a.	3a.	4a.	5a.	6a.
Jul. 7	12	13	14	15	16	17	18	19	20	21	22	23	0h.	1h
15	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	13	14	15	16	17	18	19	20	21	22	23	0	1	2
31 30	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Aug. 6	14	15	16	17	18	19	20	21	22	23	0	1	2	3
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
22	15	16	17	18	19	20	21	22	23	0	1	2	3	4
31 29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Sept. 6	16	17	18	19	20	21	22	23	0	1	2	3	4	5
13	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	17	18	19	20	21	22	23	0	1	2	3	4	5	6
30 29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Oct. 6	18	19	20	21	22	23	0	1	2	3	4	5	6	7
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	19	20	21	22	23	0	1	2	3	4	5	6	7	8
31 29	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Nov. 6	20	21	22	23	0	1	2	3	4	5	6	7	8	9
13	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	21	22	23	0	1	2	3	4	5	6	7	8	9	10
30 28	½	½	½	½	½	½	½	½	½	½	½	½	½	½
Dec. 6	22	23	0	1	2	3	4	5	6	7	8	9	10	11
14	½	½	½	½	½	½	½	½	½	½	½	½	½	½
21	23	0	1	2	3	4	5	6	7	8	9	10	11	12
Dec. 29	½	½	½	½	½	½	½	½	½	½	½	½	½	½

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Decimals of a Degree.—For valuing minutes and seconds of arc to the nearest 1/100th of a degree, and *vice versa*. (The *exact* equivalent of ·01 degree is 36″). Take the decimal equivalent just *less* than the value to be converted; or *vice versa*, the Tabular value *plus* 18″, which gives the exact value of 100ths of a degree. Thus 33′ 48″ = 0°·56 approx.; ·0°·43 = 25′ 48″.

·01	0′ 18″	·11°	6′ 18″	·21°	12′ 18″	·31°	18′ 18″	·41°	24′ 18″	·51°	30′ 18″	·61°	36′ 18″	·71°	42′ 18″	·81°	48′ 18″	·91°	54′ 18″
·02	0 54	·12	6 54	·22	12 54	·32	18 54	·42	24 54	·52	30 54	·62	36 54	·72	42 54	·82	48 54	·92	54 54
·03	1 30	·13	7 30	·23	13 30	·33	19 30	·43	25 30	·53	31 30	·63	37 30	·73	43 30	·83	49 30	·93	55 30
·04	2 6	·14	8 6	·24	14 6	·34	20 6	·44	26 6	·54	32 6	·64	38 6	·74	44 6	·84	50 6	·94	56 6
·05	2 42	·15	8 42	·25	14 42	·35	20 42	·45	26 42	·55	32 42	·65	38 42	·75	44 42	·85	50 42	·95	56 42
·06	3 18	·16	9 18	·26	15 18	·36	21 18	·46	27 18	·56	33 18	·66	39 18	·76	45 18	·86	51 18	·96	57 18
·07	3 54	·17	9 54	·27	15 54	·37	21 54	·47	27 54	·57	33 54	·67	39 54	·77	45 54	·87	51 54	·97	57 54
·08	4 30	·18	10 30	·28	16 30	·38	22 30	·48	28 30	·58	34 30	·68	40 30	·78	46 30	·88	52 30	·98	58 30
·09	5 6	·19	11 6	·29	17 6	·39	23 6	·49	29 6	·59	35 6	·69	41 6	·79	47 6	·89	53 6	·99	59 6
·10°	5′ 42′,	·20°	11′ 42″	·30°	17′ 42″	40°	23′ 42″	·50°	29′ 42″	·60°	35′ 42″	·70°	41′ 42″	·80°	47′ 42″	·90°	53′ 42″	1°	59′ 42″

Decimals of a Day.—The decimals of a minute for columns 2-10 are the same as those, *in the same line*, of the 1st column.

Dec.	h.	m.	Dec.	h.	m.	Dec.	h.	m.	Dec.	h.	m.	Dec.	h.	m.	Dec.	h.	m.	Dec.	h.	m.	Dec.	h.	m.	Dec.	h.	m.	Dec.	min.
·01	0	14·4	·11	2	38	·21	5	2	·31	7	26	·41	9	50	·51	12	14	·61	14	38	·71	17	2	·81	19	26	·91	21	50	·001	1·44
·02	0	28·8	·12	2	52	·22	5	16	·32	7	40	·42	10	4	·52	12	28	·62	14	52	·72	17	16	·82	19	40	·92	22	4	·002	2·88
·03	0	43·2	·13	3	7	·23	5	31	·33	7	55	·43	10	19	·53	12	43	·63	15	7	·73	17	31	·83	19	55	·93	22	19	·003	4·32
·04	0	57·6	·14	3	21	·24	5	45	·34	8	9	·44	10	33	·54	12	57	·64	15	21	·74	17	45	·84	20	9	·94	22	33	·004	5·76
·05	1	12·0	·15	3	36	·25	6	0	·35	8	24	·45	10	48	·55	13	12	·65	15	36	·75	18	0	·85	20	24	·95	22	48	·005	7·20
·06	1	26·4	·16	3	50	·26	6	14	·36	8	38	·46	11	2	·56	13	26	·66	15	50	·76	18	14	·86	20	38	·96	23	2	·006	8·64
·07	1	40·8	·17	4	4	·27	6	28	·37	8	52	·47	11	16	·57	13	40	·67	16	4	·77	18	28	·87	20	52	·97	23	16	·007	10·08
·08	1	55·2	·18	4	19	·28	6	43	·38	9	7	·48	11	31	·58	13	55	·68	16	19	·78	18	43	·88	21	7	·98	23	31	·008	11·52
·09	2	9·6	·19	4	33	·29	6	57	·39	9	21	·49	11	45	·59	14	9	·69	16	33	·79	18	57	·89	21	21	·99	23	45	·009	12·96
·10	2	24·0	·20	4	48	·30	7	12	·40	9	36	·50	12	0	·60	14	24	·70	16	48	·80	19	12	·90	21	36	1·0	24	0	·010	14·40

Hours and Minutes as Decimals of a Day.

Hrs.	½ hr.	1 h.	1½ h.	2 h.	2½ h.	3 h.	3½ h.	4 h.	4½ h.	5 h.	5½ h.	6 h.	6½ h.	7 h.	7½ h.	8 h.	8½ h.	9 h.
=	·0208 dy	·0417	·0625	·0833	·1042	·1250	·1458	·1667	·1875	·2083	·2292	·2500	·2708	·2917	·3125	·3333	·3542	·3750
	9½ h.	10 h.	10½ h.	11 h.	11½ h.	12 h.	12½ h.	13 h.	14 h.	15 h.	16 h.	17 h.	18 h.	19 h.	20 h.	21 h.	22 h.	23 h.
=	·3958 dy	·4167	·4375	·4583	4792	·5000	·5208	·5417	·5833	·6250	·6667	·7083	·7500	·7917	·8333	·8750	·9167	·9583

Minutes:—	1 m.	2 m.	3 m.	4 m.	5 m.	6 m.	7 m.	8 m.	9 m.	10 m.	11 m.	12 m.	13 m.	14 m.	15 m.	16 m.	17 m.
Decimal =	·0007 dy	·0014	·0021	·0028	·0035	·0042	·0049	·0056	·0062	·0069	·0076	·0083	·0090	·0097	·0104	·0111	·0118
	18 m.	19 m.	20 m.	21 m.	22 m.	23 m.	24 m.	25 m.	26 m.	27 m.	28 m.	29 m.	30 m.	35 m.	40 m.	45 m.	50 m.	55 m.
=	·0125 dy	·0132	·0139	·0146	·0153	·0160·	·0167	·0174	·0181	·0187	·0194	·0201	·0208	·0243	·0278	·0313	·0347	·0382

PRECESSION TABLES

Precession in R.A. for 10 Years. For Northern objects use the upper line of R.A. Hours; for Southern objects, the lower. The ± signs are added algebraically to the catalogue positions, like signs being added, unlike signs subtracted. For reckoning backwards, to an earlier date, reverse the + or − signs.

Hours of Right Ascension for NORTHERN Objects.

Dec.	0, 12	1, 11	2, 10	3, 9	4, 8	5, 7	6	18	19, 17	20, 16	21, 15	22, 14	23, 13	Dec.
80°	+0·51m	+0·84m	+1·14m	+1·40m	+1·60m	+1·73m	+1·77m	−0·75m	−0·70m	−0·58m	−0·38m	−0·12m	+0·19m	80°
70°	0·51	0·67	0·82	0·94	1·04	1·10	1·12	−0·10	−0·08	−0·02	+0·08	+0·21	0·35	70°
60°	0·51	0·61	0·70	0·78	0·84	0·88	0·90	+0·13	+0·14	+0·18	+0·24	+0·32	0·41	60°
50°	0·51	0·58	0·64	0·70	0·74	0·77	0·78	+0·25	+0·26	+0·28	+0·32	+0·38	0·44	50°
40°	0·51	0·56	0·61	0·64	0·67	0·69	0·70	+0·33	+0·33	+0·35	+0·38	+0·42	0·46	40°
30°	0·51	0·54	0·58	0·60	0·62	0·64	0·64	+0·38	+0·39	+0·40	+0·42	+0·45	0·48	30°
20°	0·51	0·53	0·55	0·57	0·58	0·59	0·59	+0·43	+0·43	+0·44	+0·45	+0·47	0·49	20°
10°	0·51	0·52	0·53	0·54	0·55	0·55	0·55	+0·47	+0·47	+0·48	+0·48	+0·49	0·50	10°
0°	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	+0·51m	0·51m	0°
Dec.	0, 12	23, 13	22, 14	21, 15	20, 16	19, 17	18	6	5, 7	4, 8	3, 9	2, 10	1, 11	Dec.

Hours of Right Ascension for SOUTHERN Objects.

Precession in Declination for 10 Years for objects having N. Declination. S. Declination, reverse the + or − signs.

Hours	0, 24	1, 23	2, 22	3, 21	4, 20	5, 19	6, 18	7, 17	8, 16	9, 15	10, 14	11, 13	12
	+3′·3	+3′·2	+2′·9	+2′·4	+1′·7	+0′·9	0	−0′·9	−1′·7	−2′·4	−2′·9	−3′·2	−3′·3

Example:—**The Star α Ursæ Majoris is placed in 1920 in R.A. 10 h. 58·9m., Declination +62° 11′; find its approximate position in 1950.**

Turn to the column headed by the nearest R.A. hour, 11. In this column the 10-year R.A. correction for 60°N. is +0·61m., for 70°N. it is +0·67m., giving about +0·62m. for the intermediate Dec. of the Star.

R.A. of α Ursæ Majoris for 1920	is	10h. 58·9m.
Correction for 30 years (+0·62 × 3)	,,	+ 1·9m.
R.A. for 1950		11h. 0·8m.

The Star's Declination for 1920	is	62° 11′
Correction for 30 years (−3′·2 × 3)	,,	− 10′
Dec. for 1950		62° 1′

Astronomical Signs or Symbols (occasionally-used symbols in brackets) :—

Signs of the Zodiac.	Aries	Taurus	Gemini	Cancer	Leo	Virgo	Libra	Scorpius	Sagittarius	Capricornus	Aquarius	Pisces
Symbol.	♈	♉	♊	♋	♌	♍	♎	♏	♐	♑	♒	♓

Sun, &c.—	Sun	Mercury	Venus	Earth	Moon	Mars	Minor planet	Jupiter	Saturn	Uranus	Neptune	Pluto	Comet	Star
Symbol.	☉ (◯)	☿	♀	⊕ (♁)	☽	♂	⑨	♃	♄	♅, ♁	♆	♇	☄	✶

Other Signs.	1st of Aries,	Conjunction,	Quadrature,	Opposition.	Node (longit. of).		**Moon's Phases :—**	New,	1st qr.,	Full, 3rd qr.
Symbol.	... ♈	☌	□	☍	☊ ascending		...	●	☽	○ ☾
	Longit. fr. Sun, =	0°	90°	180°	☋ descending.		Longit. from Sun, =	0°	90°	180° 270°

Symbols of Elements.—*A*, Argon ; *Al*, Aluminium ; *Be*, Beryllium ; *C*, Carbon ; *Ca*, Calcium ; *Cr*, Chromium ; *Fe*, Iron ; *H*, Hydrogen ; *He*, Helium ; *K*, Potasssium ; *Li*, Lithium ; *Mg*, Magnesium ; *Mn*, Manganese ; *N*, Nitrogen ; *Na*, Sodium ; *Ne*, Neon ; *O*, Oxygen ; *P*, Phosphorus ; *Rb*, Rubidium ; *S*, Sulphur ; *Sc*, Scandium ; *Si*, Silicon ; *Sr*, Strontium ; *Ti*, Titanium ; *Zr*, Zirconium.

Significance of + and −. **For Direction,** + indicates (*a*) northwards; (*b*) 'direct' or 'positive' motion—*i.e*, to the left, or eastwards, when looking south : − indicates (*a*) southwards ; (*b*) 'retrograde' or 'negative' motion—*i.e.*, to the right, or westwards when looking south. **Variable Stars :** + indicates that a maximum or minimum is later than the predicted date; −, that it is earlier. **Comets :** as for Variable stars, + later, − earlier, to indicate departure from the ephemeris, or the elements.

Earth's Areo-, and Zenographic Dec.—When +, the planet's North pole is presented to the Earth; when −, the South pole.

Declination :—
+ = North of Celestial eqr.
− = South „ „

Latitude :—
+ = N. } of Ecliptic, or of
− = S. } Earth's or Galact.

Longitude :— [eqr.
+ = W. }
− = E. } of Greenwich.

Libration ; mean centre :—
+ = Displaced to E. (longit.)
− „ „ W. „
+ = Displaced to S. (lat.)
− „ „ N. „
(see note, p. 29)

Magnitude :—
+ = Fainter than mag. 0·0
− = Brighter „ „ 0·0

Position Angle Sun's Axis :—
+ = N. Pole, E. } of the Hr.
− = „ W. } Circle.

Proper Motion, Precession :—
+ = Northwards (in Dec.)
− = Southwards „
+ = Direct (in R.A.)
− = Retrograde „

Light-time. + later, − earlier.

(see pp. 6, 11)

Radial Velocity :—
+ = Recession from Sun.
− = Approach to „

Saturn's Rings :— (p. 32).
+ = Earth N. of ring-plane.
− = „ S. „ „

Sun's Equator :— (p. 40).
+ = S. of centre of disc.
− = N. „ „

Astronomical Contractions.—Those for Astronomical Societies, Publications, Star catalogues, &c., are given on pp. vi-vii.

℞	Right Ascension	G.C.T.	Greenwich Civil Time	K.	Kelvin (Abs. temp., p. 17).	P.M.	Proper Motion
A.U.	Astronomical Unit	G.M.A.T.	„ Mean Astron. Time	Lat.	Latitude	R.A.	Right Ascension
„	Angstrom Unit	G.M.N.	Greenwich Mean Noon	Long.	Longitude	U.T., T.U.*	Universal Time
C.I.	Colour index	G.M.T.	„ „ Time	Mag.	Magnitude	S.D.	Semi-diameter
C.M.	Central Meridian	H.I.	Heat Index	N.P.D.	North Polar Distance	Z.D.	Zenith distance
Dec.	Declination	H.P.	Horizontal parallax	N.P.S.	„ „ Sequence	*nf*	North following.
Eqr.	Equator	I.A.	International Angstrom	O. − C.	Observed − calculated	*np*	„ preceding.
Gal.	Galactic	J.D., J.P.,	Julian Day & Period	P.A.	Position Angle	*sp*	South preceding.
G.E.	Greatest elongation	J.A.D.	„ Astr. Day, p. 9.	P.E.	Probable error	*sf*	„ following.

(see p. 39)

d, days ; *h.*, hours; *m.*, minutes; *s.* seconds. *mm.*, millimetres ; *cm.*, centimetres ; *km.*, kilometres. *l/y*, light-years.

Astronomical Symbols for Positions, Magnitudes, Parallaxes, &c. (fuller list facing front cover). (I.A.U. proposed, 1935).

α	Right Ascension	*Az*	Azimuth, *h* Altitude	λ	Wave-length, in Angstroms, p. 22
δ	Declination	*z*	Zenith Distance	μ	Micron, = 1/1000th mm. = λ10,000
β	Latitude (celestial), geocent.	*H* or *t*	Hour Angle	$\mu\mu$	1/millionth mm. = λ10
λ	Longitude „ „	π	Parallax, annual, in ″.	ϵ	Obliquity of Ecliptic
G	Galactic longitude	P_0	„ equatorial horizontal	*P*	Orbital period
g	„ latitude	*p*	Annual precession (general)	*E*	Time, Equation of
b	Heliocentric latitude	*p*	Position angle, p. 5.	*t*	„ of observation
l	„ longitude	μ	Proper motion (total annual)	t_m	„ mean : t_v True time.‡
ϕ	Geographical latitude: ϕ' geo-	*R*, *T*, *W*,	Velocity,† radial (re-	θ	„ sidereal: θ_0 at mean midnight
L	„ longitude, + W. [centric		ceding +), tangential, spatial.		

M	Magnitude, absolute
m	„ apparent
m_v	„ „ visual
m_{pv}	„ „ photovisual
m_{pg}	„ „ photographic
m_{ipg}	„ „ internat. pg.
m_{bol}	„ „ bolometric
m_{rad}	„ „ radiometric
m_{pr}	„ „ photo-red
m_{pir}	„ „ infra-red

Constellation Abbreviations. Three- and four-letter contractions (Int. Astr. Union, 1922, -32). (Malus replaced by Pyxis.

And	Andromeda	Andr	Cha	Chamæleon	Cham	Eri	Eridanus	Erid	Men	Mensa	Mens	Scl	Sculptor	Scul
Ant	Antlia	Antl	Cir	Circinus	Circ	For	Fornax	Forn	Mic	Microscop'm	Micr	Sco	Scorpius	Scor
Aps	Apus	Apus	CMa	Canis Maj.	C Maj	Gem	Gemini	Gemi	Mon	Monoceros	Mono	Sct	Scutum	Scut
Aql	Aquila	Aqil	CMi	Canis Min.	C Min	Gru	Grus	Grus	Mus	Musca	Musc	Ser	Serpens	Serp
Aqr	Aquarius	Aqar	Cnc	Cancer	Canc	Her	Hercules	Herc	Nor	Norma	Norm	Sex	Sextans	Sext
Ara	Ara	Aræ	Col	Columba	Colm	Hor	Horologium	Horo	Oct	Octans	Octn	Sge	Sagitta	Sgte
Arg	Argo	Argo	Com	Coma Ber.	Coma	Hya	Hydra	Hyda	Oph	Ophiuchus	Ophi	Sgr	Sagittarius	Sgtr
Ari	Aries	Arie	CrA	Corona Aus.	Cor A	Hyi	Hydrus	Hydi	Ori	Orion	Orio	Tau	Taurus	Taur
Aur	Auriga	Auri	CrB	Corona Bor.	Cor B	Ind	Indus	Indi	Pav	Pavo	Pavo	Tel	Telescop'm	Tele
Boo	Boötes	Boot	Crt	Crater	Crat	Lac	Lacerta	Lacr	Peg	Pegasus	Pegs	TrA	Triang. Aus.	Tr Au
Cae	Caelum	Cæl	Cru	Crux	Cruc	Leo	Leo	Leon	Per	Perseus	Pers	Tri	Triangulum	Tria
Cam	Camelopard.	Caml	Crv	Corvus	Corv	Lep	Lepus	Leps	Phe	Phœnix	Phœ	Tuc	Tucana	Tucn
Cap	Capricornus	Capr	CVn	Canes Ven.	C Ven	Lib	Libra	Libr	Pic	Pictor	Pict	UMa	Ursa Major	U Maj
Car	Carina	Cari	Cyg	Cygnus	Cygn	LMi	Leo Minor	L Min	PsA	Piscis Aust.	Psc A	UMi	Ursa Minor	U Min
Cas	Cassiopeia	Cass	Del	Delphinus	Dlph	Lup	Lupus	Lupi	Psc	Pisces	Pisc	Vel	Vela	Velr
Cen	Centaurus	Cent	Dor	Dorado	Dora	Lyn	Lynx	Lync	Pup	Puppis	Pupp	Vir	Virgo	Virg
Cep	Cepheus	Ceph	Dra	Draco	Drac	Lyr	Lyra	Lyra	Pyx	Pyxis	Pyxi	Vol	Volans	Voln
Cet	Cetus	Ceti	Equ	Equuleus	Equl	(Malus = Pyxis)		...	Ret	Reticulum	Reti	Vul	Vulpecula	Vulp

* Germany, W.Z. Weltzeit. † Relative to the Sun. ‡ From mean and true midnight.

A STAR ATLAS

AND REFERENCE HANDBOOK

I.—NOTES ON STAR NOMENCLATURE, &c.

The Constellations.—The origin of most of the constellation names is lost in antiquity. COMA BERENICES was added to the old list (though not definitely fixed till the time of Tycho Brahé), about 200 B.C.; but no further addition was made till the seventeenth century, when Bayer, Hevelius, and other astronomers, formed many constellations in the hitherto uncharted regions of the southern heavens, and marked off portions of some of the large or ill-defined ancient constellations into new constellations.* Many of these latter, however, were never generally recognised, and are now either obsolete or have had their rather clumsy names abbreviated into more convenient forms. Since the middle of the 18th century, when La Caille added thirteen names in the southern hemisphere, and sub-divided the unwieldy Argo into Carina, Malus (now Pyxis), Puppis, and Vela, no new constellations have been recognised. Originally, constellations had no boundaries, the position of a star in the 'head,' 'foot,' &c., of the figure answering the needs of the time; the first boundaries were drawn by Bode in 1801. For List of Constellations, see last page.

Star Nomenclature.—The star names given on the last but one page have, for the most part, been handed down from classical or early mediæval times, but only a few of them are now in use, a system devised by Bayer in 1603 having been found more convenient, viz., the designation of the bright stars of each constellation by the small letters of the Greek alphabet, α, β, γ, &c., the brightest star being usually made α, the second brightest β—though sometimes, as in Ursa Major, sequence, or position in the constellation figure, was preferred. When the Greek letters were exhausted, the small Roman letters, a, b, c, &c., were employed, and after these the capitals, A, B, &c.—mostly in the Southern constellations. The capitals after Q were not required, so Argelander utilised R, S, T, &c., to denote *variable* stars in each constellation, a convenient index to their peculiarity (see also p. ix).

The fainter stars are most conveniently designated by their numbers in some star catalogue. By universal consent, the numbers of Flamsteed's British Catalogue (published 1725) are adopted for stars to which no Greek letter has been assigned, while for stars not appearing in that catalogue, the numbers of some other catalogue are utilised. The usual method of denoting any lettered or numbered star in a constellation is to give the letter, or Flamsteed number, followed by the genitive case of the Latin name of the constellation: thus α of Canes Venatici is described as α Canum Venaticorum. These genitives are given in the list of constellations on the last page, facing the cover.

Flamsteed catalogued his stars by constellations, numbering them in the order of their 'Right Ascension'—that is, the number of hours and minutes they southed after the southing of a certain zero point among the stars (p. 2). Most modern catalogues are on this convenient basis (ignoring constellations), as the stars follow a regular sequence. But when Right Ascensions are nearly the same, especially if the Declinations (p. 3) differ much, in time 'precession' may change the order: Flamsteed's 20, 21, 22, 23 Herculis, numbered 200 years ago, now south in the order 22, 20, 23, 21.

For convenience of reference, the more important star catalogues are designated by recognised contractions: thus "B.A.C. 2130" is at once known by astronomers to denote the star numbered 2130 in the British Association Star Catalogue of 1845. In most star catalogues a number is assigned to each star included in them, whether it has a Greek or other letter, or not. Thus, *Vega* is α Lyræ, 3 Lyræ (Flamsteed's number), and (constellations ignored) Groombridge 2616. A list of some of the best-known catalogues, and their contractions, is given on p. vii.

Constellation Boundaries.—Bode's boundaries were not treated as standard, and charts and catalogues issued before 1930 may differ as to which of two adjacent constellations a star belongs. Thus Flamsteed numbered in Camelopardus several stars now allocated to Auriga, and by error he sometimes numbered a star in two constellations. Bayer, also, sometimes assigned to the same star a Greek letter in two constellations, ancient astronomers having stated that it belonged to both constellation figures: thus β Tauri = γ Aurigæ, and α Andromedæ = δ Pegasi.

To remedy this inconvenience, in 1930 the International Astronomical Union standardised the boundaries along the Jan. 1, 1875, arcs of Right Ascension and Declination, having regard, as far as possible, to the boundaries of the best star atlases. The work had already been done by Gould on that basis for most of the S. Hemisphere constellations.

* Antinous, added in A.D. 130 by the Emperor Adrian, was long combined with Aquila as 'Aquila et Antinous.'

The I.A.U. Boundaries.—These do not change their positions among the stars, thus objects can always be correctly located, though, owing to precession, the arcs of Right Ascension and Declination of to-day no longer follow the boundaries, and are steadily departing from them. After some 12,900 years, however, these arcs will begin to return towards the boundaries, and 12,900 years after this, on completing the 25,800-year precessional period (p.6) will approximate to them, but not exactly coincide.

II. NOTES ON ASTRONOMICAL TERMS.

The Star Sphere, a convenient term used in speaking of the heavenly bodies and their relative positions, derives its name from the appearance of the heavens to an observer: he seems to be at the centre of a vast hollow sphere (half of it unseen, beneath his feet), which revolves round the Earth once each day. The stars seem permanently fixed to the inside surface of this sphere—their vast distances practically nullify their actual rapid motions—and are known as *fixed stars*, in contrast to the 'wandering stars' or *planets*, which move among the others. Rather more than half the star sphere is seen at one time, as refraction adds a strip equal to the breadth of the Moon's disc in the sky.

The Celestial Poles and Equator.—The pivots, as it were, on which the star sphere revolves, are called the *Celestial Poles*; they are directly overhead at the Terrestrial Poles. Half way between them is the great circle of the *Celestial Equator* or *Equinoctial*, which passes directly overhead at every point on the Terrestrial equator.

Culmination: Southing.—A celestial object *culminates* when it reaches its highest point above the observer's horizon. In the N. Terrestrial hemisphere, *souths* is used in the same sense, as culmination is always at the instant when the object is due south of the N. Pole; in the S. Terrestrial hemisphere, objects culminate when due north of the S. Pole.

Rising and Setting of Stars.—At the Terrestrial Equator, the Celestial poles lie on the horizon; all the stars remain above the horizon for half a day, and their rising and setting are at right angles to the horizon. At the Terrestrial poles, on the other hand, the Celestial equator coincides with the horizon, parallel with which the stars move in circles, neither rising nor setting, the other half of the star sphere being never seen.

In intermediate latitudes there is every variety between these extremes, but always some stars never set (and a corresponding area round the opposite Pole never rises), also the paths in the sky cut the horizon obliquely—all in proportion to the observer's nearness to, or remoteness from, the Terrestrial Pole or Equator.

The stars which rise and set always do so at the same points on the horizon—unlike the Sun, Moon, and planets, which rise and set at different points on successive days. In temperate latitudes, especially, those of them nearest the observer's Celestial pole rise far north (S. hemisphere, *south*), and are above the horizon most of the twenty-four hours; as distance from the Celestial pole increases, they rise further and further south (or *north*), and their time above the horizon diminishes, till, for the stars furthest south (or *north*), they set again a very short time after rising. Stars on the Celestial equator rise due E., set due W., and are 12 hrs., above the horizon, all over the Earth—except at the Poles.

Stars rise, 'south' or 'north', and set, at a given hour *only once a year*, always on or about the same date, for they culminate nearly four minutes earlier each day, and make $366\frac{1}{4}$ revolutions in $365\frac{1}{4}$ solar days. On one day in the year 'southing,' &c., occurs *twice*, for when a star souths at 12·1 a.m. it will south again at 11·57 p.m. the same day. This occurs with the Superior planets (p. 32) also—Mars, and the asteroids in general, about each second year—their mean daily motions being less than the Earth's. Mars and Venus, however, may not south at all on one day in the year.

The Stars that never set or rise.—Stars never set when their distance from the Celestial pole is less than the latitude of the observer on the earth. Or, stars with Declination (p. 3) greater than the observer's *Co-latitude* his latitude subtracted from 90°) never set; the corresponding area round the opposite Pole never rises.

The Ecliptic is another important great circle on the star sphere, which intersects the Celestial equator at an angle of $23\frac{1}{2}°$ (the *Obliquity of the Ecliptic**), and lies in a plane which passes through the centres of the Sun and the Earth: it represents the yearly path of the Sun's centre on the star sphere, as seen from the Earth, or the Earth's as seen from the Sun: it is shown in Maps 3-14. *The Ecliptic Poles*, the points on the star sphere 90° from the Ecliptic, (about $23\frac{1}{2}°$ from the Terrestrial poles), are at R.A. 18h., and 6h., and Dec. $66\frac{1}{2}°$ N., and S., respectively.

The Ecliptic and its poles are 'sensibly' (*i.e.*, for ordinary purposes) fixed on the star sphere, but change slightly in centuries.

The former also represents (*a*) the central line of the Zodiac (p.3); (*b*) the average path of the Moon, Mercury, and Venus, on the star sphere (pp. 8, 33), but not those of the other major planets—though these are always *near* the Ecliptic, except Pluto.

The Vernal Equinox or **First Point of Aries**, the zero for the celestial measurements corresponding to terrestrial longitude, is the point of intersection on the star sphere, at any moment, of the Celestial Equator and the Ecliptic, at or near the point where the Sun crosses the former from S. to N., about March 21.

This point—the *True* or *Apparent Equinox*, or *The Equinox* of any date—moves westward on the Ecliptic 1/7th second of arc every day, but is nevertheless the most convenient point for the purpose, as the Sun's position in the sky, measured from it, remains practically the same on a given day of the year for thousands of years, by the leap year arrangements of the calendar, though those of the stars slowly change. 'Vernal Equinox,' *when used in connection with measurements*, always means this moving True Equinox, but the *literal* Vernal (Spring, p. 6) equinox is the instant when the Sun's centre actually crosses the Celestial equator.

The Mean Equinox, is the True Equinox corrected for the irregularity (max. ± $1\frac{1}{4}$ secs.) called nutation in Right Ascension (p. 7). Positions in star charts and catalogues are measured from it, at the time when the Sun's mean longitude is 280°, about Jan. 1: thus for 1950, the star positions are called 'mean places for 1950·0' —'·0' after a year always indicates the 280° start.

The position of the First Point of Aries is about nine moon-breadths W. of the end of a line drawn first from α Andromedæ to γ Pegasi (which form one side of the 'Square of Pegasus') then extended downwards for the same length.

* Mean, Jan. 1, 1950, 23° 26′ 45″ (annual decrease 0″·47), may vary 9″ from mean.